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ABSTRACT

This is the first in a series of reports which summarize research studies dealing with college level economics education that is personalized, individualized, or self paced. The major purpose is to inform interested economic educators of the studies that have been done, to summarize the results, and to identify various research designs and statistical techniques that others might want to use. Forty studies are described. Most were done in the 1970s. The introductory 15 pages give an overview of the research. Most studies indicate that personalized or individualized instruction is as effective as the traditional lecture discussion approach. Many suggest that programmed materials save time for both student and instructor and can be less expensive than the traditional approaches. The use of television, computer assisted instruction, tutors, and case studies is tested in several studies, and some deal with various combinations of approaches. Some researchers believe that no single method is best, but that certain combinations such as programmed instruction with games and simulations or with an audio visual tutorial system yield superior results. (Author/RM)

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RESEARCH IN ECONOMIC EDUCATION

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A SUMMARY OF RESEARCH IN PERSONALIZED, INDIVIDUALIZED, AND SELF-PACED INSTRUCTION IN COLLEGE ECONOMICS

George G. Dawson

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A SUMMARY OF RESEARCH IN PERSONALIZED, INDIVIDUALIZED, AND SELF-PACED INSTRUCTION IN COLLEGE ECONOMICS

by

George G. Dawson

INTRODUCTION

This is the first in a series of reports on research in economic education being prepared by the Empire State College Center for Business and Economic Education. The CBEE was established late in 1976. Upon becoming officially affiliated with the New York State Council on Economic Education and the Joint Council on Economic Education in February of 1976, the CBEE was designated by the Joint Council as the "National Center for Personalizing Instruction in Business and Economics." (See Page 4 of Progress in Economic Education, Volume 7, Number 5, September, 1976, published by the Joint Council.) Shortly thereafter, the CBEE produced its first publication, Personalizing Instruction in Business, Economics and Related Subjects. Complimentary copies of this 56-page report were sent to every affiliated Center and Council in the United States.

Interest in personalized, individualized, and self-paced instruction seems to be growing. Many college teachers are raising questions about the efficiency of the old "lock-step" curriculum, an educational situation in which students in a given course are expected to move at the same pace, using the same (or similar) materials, and being exposed to the same teaching techniques. We do not expect all students to wear the same

size shoes, but somehow we often think that a prescribed curriculum and method of instruction should "fit" every individual. Several factors probably helped to motivate college economists to try new approaches, to experiment with unconventional educational materials and equipment, and to recognize that what is right for one student may be very wrong for another. Reports that students were avoiding economics, that there was little evidence of the residual impact of economics instruction, and that the student uprisings of a few years ago were caused (at least in part) by dissatisfaction with our teaching may have contributed. Furthermore, economists habitually consider the costs and benefits of everything else, so why not attempt to measure the costs and benefits of economics courses? In any event, the 1970's have seen a dramatic increase in research in the teaching of economics at the college level. At least 750 studies of one kind or another have been made of economic education for college students or adults, and over 500 of those appeared in the 1970's. (See George G. Dawson, "Special Report: An Overview of Research in the Teaching of College Economics," The Journal of Economic Education, Spring, 1976, pp. 111-116.)

As part of its obligation in serving as the national center for information on personalized instruction, the Empire State College CBEE began to collect studies in any way involving self-paced, individualized, or personalized methods. Lists of research were examined, and about 60 titles were identified that

seemed in some way to suggest relevant studies. Upon examination, some of these papers proved to contain little or nothing on the subject. Others merely represented duplication. That is, some researchers produce two or more papers on the same project, perhaps changing the title and modifying the text, but reporting nothing new or different. Efforts were made to obtain copies of every study that was uncovered, but the success rate was less than 100 percent. It cannot be claimed, then, that this report contains everything that has been done on our subject. Readers are urged to apprise us of anything we have missed or overlooked.

The fact that a study is included in this report does not imply that the Center considers it to be an excellent piece of research. The research varies in quality and importance. Our major purpose is to inform interested economic educators of the studies that have been done, to summarize the results, and to identify various research designs and statistical techniques that others might want to use. It is hoped that this booklet will help other researchers who wish to survey the literature in the field, saving them considerable time and effort. Remember, however, that no study has been presented in its entirety. Indeed, we have reduced one 200-page thesis to a page and a half! Our summaries may help the reader decide which papers to obtain for detailed analysis, however. Those planning research in personalized, individualized, or self-paced instruction should examine the work of others, noting their successes and failures,

and their strengths and weaknesses.

What do we know from research that has been completed, and what else needs to be done? First, there is ample evidence that self-paced, individualized, and personalized instruction can be effective in teaching economics to college students. Petr (pp. 36-37 below) and Spector (pp. 45-48 below) found the Keller method of personalized instruction to be superior to conventional methods in undergraduate classes, while Roop's study (pp. 37-38 below) of contingency management indicated superiority for that approach over conventional techniques in an intermediate microeconomics course. On the other hand, Soper and Thornton (pp. 43-44 below) found self-pacing to be inferior. Most others find the various forms of personalized, individualized, or self-paced instruction to be as effective as the traditional lecture-discussion approach, at least as measured by objective tests of economic knowledge and understanding.

Many suggest that programmed materials and some of the other techniques save time for both student and instructor. That is, students can often learn some of the basic economic principles on their own, thus enabling the teacher to use class time to apply the concepts to economic issues and problems, and/or enabling the student to devote more time to other studies. For examples of the time-saving argument see the Attiyeh, Bach, and Lumsden study (pp. 3-4 below) and the Wetzel study (pp.55-56 below).

The value of lectures is questioned in several studies. The

Buckles-McMahon paper (pp. 12-13 below) deals with this issue, and McConnell and Lamphear (pp. 28-29 below) assert that lectures are not always necessary even for the poorer student. It is dangerous to generalize, however, because the studies reported here cover a wide variety of situations, practices, and materials.

The use of programmed materials is dealt with in many of the studies, and the usual finding is that programmed textbooks are effective in teaching economics. Havrilesky warns, however, that we must consider the time dimension. (See p. 22 below.) That is, programmed materials may be effective when used for short periods, but their impact might decline if the period of use is extended. This is a question that definitely calls for additional research. The popularity of programmed materials with students is still a matter of dispute -- Lumsden reporting them to be most popular (see p. 28 below), while Luker finds them to be least popular (see p. 27 below).

The use of television, computer-assisted-instruction, tutors, and case studies is also tested in several studies, and some deal with various combinations of approaches. In fact, some researchers believe that no single method is best, but that certain combinations yield superior results. Luker, for example, tried four teaching methods and concluded that a combination of programmed instruction with games and simulations worked best. (See pp. 26-27 below.) Tolles and Ginman also thought that a combination -- in this case an audio-visual-tutorial system with

conventional class discussion methods -- was superior. (See p. 51 below.) This, again, is another area in which much more research is required, for the number of possible combinations is almost limitless.

Several of the authors considered the costs of the various experimental techniques as compared with the costs of conventional instruction. This is particularly important where one finds no significant difference in effectiveness between methods. Generally, it has been found that several of the personalized, individualized, or self-paced schemes can be less expensive than traditional approaches. Mellish and Bostow (See pp. 29-30 below) claim that their use of the Keller method of personalized instruction cut the per-student cost by about fifty percent. Booms and Kaltreider, on the other hand, found that their use of computers increased some of the unit costs. (See pp. 9-10 below.) Some consider costs in terms of student time as well as money and other college resources expended. Becker and Salemi (see pp. 5-8 below) found that there were savings in terms of the opportunity cost of student time. Allison (pp. 1-3 below) treats self-paced instruction as a new technology in a production process. Her study suggests that one must distinguish between the higher initial costs experienced when a new program is being started and the costs over the longer run period. In any event, researchers should include a cost-output dimension in all studies of this type.

The lasting effects of the experimental methods have been considered by several researchers. The period in question is usually relatively short, however. The students are tested again a few months or a year after the experimental treatment. Lasting effects were considered by Booms and Kaltreider (pp. 9-10 below), Craig and O'Neill (p. 15 below), Kelley (p. 24 below), Siegfried and Strand (p. 40 below), Spector in his second paper (pp. 46-48 below), and Tietenberg (pp. 48-51 below). Craig and O'Neill thought that self-instruction aided in retention, at least for those items in the "complex-application" portion of the Test of Understanding in College Economics. Students exposed to Kelley's Teacher Information Processing System (TIPS) maintained their superiority after a year (p. 24 below), but Siegfried and Strand (p. 24 below) found that students getting personalized instruction enjoyed no advantage over conventionally-taught students even after one semester. Spector's P.S.I. students did better when they got into intermediate classes, while Tietenberg found no significant difference. Thus, "the jury is still out" on the residual impact of personalized instruction, especially for periods of over one year.

The disaggregation of data to test for differential effects on different types of students is a matter of considerable importance. Billings asserts that P.S.I. is "rewarding" for all kinds of students (pp. 8-9 below), but Allison feels that self-pacing is best for freshmen and the "less brilliant." Those

agreeing with Allison are Fusfeld and Jump (pp. 18-19 below), Kelley (p. 24 below) and O'Connor (p. 34 below). On the other hand, Havrilesky thought that his programmed text was more suitable for the better student (p. 22 below). Negus (pp.30-31 below) also took this position, and Tietenberg tended to agree. Clearly, all future research should attempt to disaggregate the data. It must not be assumed that a technique that appears to be good for all students as a group, or for students of a particular level of ability, will likewise be good for students with differing characteristics. It should be noted, too, that few studies went beyond a single college. The Attiyeh-Bach-Lumsden study (pp. 3-4 below) is one of the few multi-school research projects, involving 48 schools and over 4000 students. Two-year colleges have been largely ignored, except for the Becker-Salemi and Walstad studies. Where differences are found between colleges, it is important to try to ascertain the reasons.

Many studies have tried to measure student attitudes toward the course and the method of instruction, finding that students are often (but not always) favorably disposed toward the experimental techniques. Little or nothing has been done, however, to ascertain possible effects of the treatments on student attitudes or opinions toward economic issues. This, indeed, is a wide-open area for future research.

The quality and characteristics of the teacher is another matter that needs further study. Bach's study (pp. 4-5 below) deals with this, and Van Metre suggests that the teacher's expec-

tations and motivation might have a bearing on course outcomes. Indeed, Van Metre warns that failure to consider the teacher along with the method may be a great weakness in much of the research. He is probably correct in noting that a given method should not be considered in isolation -- that a technique that works well for one teacher may not work well for another. Our experience at Empire State College supports this. The ESC mode of instruction calls for one-to-one relationships between instructors and students, with the teacher as a guide and mentor rather than an omniscient and dictatorial expert. Those who see their role as telling students what to do, unilaterally establishing degree programs and criteria for evaluation, and developing standardized lock-step curricula do not do well in this College.

Most of the research has concentrated on the introductory course in principles of economics. However, O'Connor (pp. 33-34 below) dealt with students in an intermediate micro course (as did Tietenberg), while Roop's study involved those in intermediate macro (pp. 37-38 below). A few included both introductory and intermediate levels, usually by considering the effects of the experimental treatment at the lower level on the students after they had reached the intermediate level. (See the discussion of "lasting effects" above.)

Since some of the experimental techniques involved the use of tutors, the impact on those tutors has been a matter of concern. Upper division students are often used as tutors or

"proctors," and some find this practice to be effective and inexpensive. The student-to-student tutoring system described by Kelley and Swartz (pp. 25-26 below) had a positive impact on student performance. Seigfried and Strand (pp. 39-41 below), using the 100-item CLEP test in economics, found that their tutors learned much more through proctoring than they would have by taking an advanced economics course.

Future researchers should pay particular attention to the research designs, statistical techniques, and testing procedures used in these studies. Note the problems encountered by the authors, and their weaknesses as well as their strengths. First let us look at the problem of testing. Which test does one use? A standardized test such as the TUCE (Test of Understanding in College Economics) has the advantage of having been developed by a team of experts and having norm data based upon nationwide administration and validation of the instrument. The major disadvantage is that a standardized test may include material not covered in the course and may omit some things that were covered. Furthermore, it may measure knowledge, understanding, and perhaps the ability to apply economic concepts to new situations, but it does not reveal student interest or attitudes toward the course or toward economic issues. Anyone not familiar with the TUCE should obtain a specimen set, which includes a manual, samples of the four 33-item forms, and scoring keys. Part I of the TUCE deals with basic macroeconomics; Part II deals with microeconomics. There are two forms (A and B) for each part so that one can

administer a post-test that covers the same concepts found in the pre-test without repeating the questions verbatim. This test was published in 1967 by the Psychological Corporation, but it is now sold by the Joint Council on Economic Education, 1212 Avenue of the Americas, New York, N.Y. 10036. (The price for the specimen set is $5.00.) There is also an unpublished "Hybrid TUCE," a 33-item multiple-choice test drawn from the various parts of the TUCE proper, and covering both micro and macro. Those wishing to use this shorter version of the TUCE should write to the Joint Council's Director of College and University Program for a copy and for permission to use it. Many of the projects reported in this booklet employed the TUCE.

Before the TUCE was developed, many researchers used the Test of Economic Understanding, published by Science Research Associates. The TEU was originally designed for use in senior high schools, but it has been widely employed with college students and adults as well. This test has two forms covering the same basic concepts. There are 50 items in each form. It was published in 1964, so the TEU is now considered to be out of date, and the norm data are probably no longer appropriate even for secondary school students. It is expected that the TEU will be replaced in the near future by the Test of Economic Literacy being developed under the direction of John Soper at Northern Illinois University. Soper plans to draw upon a variety of sources (including the college-level TUCE) in constructing this new instrument.

Some of the researchers developed tests of their own to overcome the problem of using standardized instruments that might not be appropriate for their particular classes. See Seigfried and Strand (pp. 39-41 below) for an example of this. The problem here, of course, is that one cannot then compare the results for a particular population with a nation-wide norming sample, or with results obtained by other researchers who used a standardized test. Some researchers have relied, at least partially, on a test-question bank maintained by the Joint Council on Economic Education. (See Buckles and McMahon pp. 12-13 below.)

The way in which a test is used may be as important as the test itself. The test should have an effect upon the student's grade -- otherwise students will not bother to exert much effort and the test results will be meaningless. Hanni makes this point very clearly (pp. 20-21 below) and even questions the usefulness of the TUCE on the ground that some of the instructors administering it to collect norm data may not have made it part of the student's final grade.

Research design and statistical techniques are stressed in several of the studies. Questions might be raised about those experiments in which students were permitted to choose between experimental and control sections, unless the researchers in some way adjusted for this. (See Kelley and Swartz, p. 25 below, for example.) Disaggregation is urged by several of the authors, and we have already mentioned one way of doing this above. Note also that the TUCE items are divided into three categories --

"recognition and understanding," "simple application," and "complex application." It is suggested that researchers disaggregate the data in these terms, for one may find that an experimental method is more effective in promoting one type of learning as opposed to the two others. (See Craig and O'Neill, p. 15 below, for example.)

Readers concerned about research design might be particularly interested in Allison's treatment of self-paced instruction as a new technology in a production process, the multiple baseline and reversal techniques described by Bostow and Mellish, the problem of multicollinearity as discussed by Soper and Thornton (pp. 43-44 below), and Tietenberg's "breakeven point" GPA and use of discriminant analysis. Note the several dependent variables used by O'Connor, and pay particular attention to the "gap-closing model." Many economic education researchers now use the gap-closing score as opposed to (or in addition to) a simple gain score. The gap is the difference between the student's pre-test score and a perfect score -- say ten points. If the student's gain score is five points, then the gap-closing score is 50 percent. The use of the gap-closing model seems to have solved some of the problems encountered when one uses a simple gain score. (For a recent discussion of this, see Paul H. Kipps, Howard M. Wilhelm, and Daniel R. Hall, "A Note on the Use of Multiple Regression Analysis in Studies of Achievement in Economics," The Journal of Economic Education, Spring, 1976, Volume 7, Number 2, pp. 130-132.) The Becker-Salemi paper is also

of interest, and one of the fascinating things about the Siegfried-Strand study is that the researchers addressed themselves to many of the criticisms made of earlier projects and to some of the questions raised by previous research. The research-minded reader will also want to see the "Special Section" in the Fall 1976 issue of The Journal of Economic Education, "A Debate on Research Techniques in Economic Education."

If all of this research does not provide overwhelming support for those committed to personalized, individualized, and self-paced instruction, neither does it imply that they ought to be scrambling back to the lecture hall. Indeed, even those who found the experimental treatments to be less effective than the conventional methods usually had something positive to say about them. It is probably safe to conclude that these approaches constitute another useful instrument in the college teacher's tool kit, and that their benefits have been fairly well established.

Most of the research has been done in the context of a traditional institutional setting. Sometimes the experiment consumed only a few weeks of a semester-long conventional course, and sometimes the treatment was administered in conjunction with the traditional medicine. Few, if any, of the experiments are comparable to the educational methodology employed at Empire State College. Nearly all students at Empire State College study independently, under the guidance of a faculty mentor. A dozen students may be learning economics at the same time at one of our centers, but using different textbooks and materials, doing very different

assignments (assignments often related in some way to their jobs), being evaluated in different ways, and proceeding at different rates of speed. Those of us at ESC think this is a very effective method of teaching, but we are still pressed by our colleagues elsewhere to "prove it." A model for program effectiveness and related costs (PERC) is being developed by Ernest Palola, ESC's Assistant Vice-President for Research and Evaluation. Preliminary research suggests that the ESC mode is, in general, both effective and economical. We do need further evidence on the teaching of business and economics, however. Lloyd Lill of the ESC Center in Rochester is making a study of the cost-effectiveness of business programs at Empire State College, and Jeffrey Sussman of the Long Island Center is planning a project to measure student learning of economics through our system of personalized, self-paced, and individualized instruction. Meanwhile, we are fairly confident that we are not wasting student time or taxpayers' money. We are indebted to the many scholars whose work is reported in this booklet, and we hope in the future to be able to add substantially to the findings reported here.

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SUMMARIES OF STUDIES IN
PERSONALIZED, INDIVIDUALIZED, AND SELF-PACED
INSTRUCTION IN ECONOMICS

Allison, Elisabeth, "Self-Paced Instruction: A Review," The Journal of Economic Education. Fall, 1975, Volume 7, Number 1. Pp. 5-12.

Allison notes that over 80 colleges and universities have adopted self-paced introductory courses and predicts further growth in the future. She comments on the benefits and costs, summarizing the results of several studies. (These studies will be described elsewhere in this report.) She concludes that "the evidence on SPI's educational benefits is at present inconclusive." Finding that SPI has not demonstrated superiority in raising student scores on standardized economics tests, she asserts that its use is justified on such criteria as intuitive appeal, student and teacher satisfaction, and "an interest in concentrators."

The costs of running a self-paced system are identified, and Allison points out that these vary with the format selected. Costs borne by the student as well as by the instructors and graders are considered. The steps for setting up an SPI course are listed and discussed, including the defining of units, the writing of objectives, the choosing of the test format, the preparation of other course materials, the hiring of graders, and the choosing of a grading system. Allison criticizes the studies she reviewed for not including cost figures and for not giving enough thought to experimental design.

Finally, she calls for disaggregating the data to test for differential effects on different types of students. To the extent that SPI does increase learning, there is a need to understand why.

* * * * * * * * * * *

Allison, Elisabeth, "Three Years of Self-Paced Teaching in Introductory Economics at Harvard," American Economic Review. May, 1976, Volume 66, Number 2. Pp. 222-228.

Also see: Elisabeth Allison, "Self-Paced Instruction in the Introductory Economics Course," Harvard Institute of Economic Research, paper no. 368, 1974.

Allison identifies the benefits and costs of SPI, the way it changes the learning process, and which students find it most

helpful. She finds that "under the right circumstances, the marginal product of SPI is a 10-20 percent increase in scores and that it inspires students to take more courses in economics." (AER, p. 222.) On the other hand, the initial cost of establishing the "right circumstances" is high, the benefits are not uniformly distributed, and after an initial period of enthusiasm the students are no happier than they are in conventional courses.

The Harvard approach was to prepare a list of operationally stated course objectives and a set of unit tests which the students could take whenever they believed they had mastered an objective. Upon failing an exam, the student could take another test on the same material. There was no limit on the number of attempts permitted, and full credit was given when an exam was passed. SPI was introduced into three sections of about 30 students each, selected at random.

The original intention was to follow a conventional evaluation format -- "estimating an achievement equation in which a test score was the dependent variable and SAT scores, age, sex, and grade point average (GPA), the controls...." (AER, p. 223.) This was scrapped, however, in favor of a scheme in which SPI would be treated as a new technology in a production process. Allison does not claim to have found the best model for evaluating SPI, for there was a serious "errors-in-variables" problem, and they felt hampered by the lack of a generally accepted theory of learning.

It was assumed that students allocate their efforts among courses and other activities in such a way as to maximize some function. Thus, a student choosing to devote some effort to economics faces a production function defined by his or her ability, teacher quality, and the instructional method (SPI). Enjoyment of the course will depend upon "profit" -- the difference between the grade and the cost (psychic or financial) to the student. Thus, equations were developed for effort, for achievement, and for enjoyment. Finally, the desire to take further economics courses was seen as an important output, so a concentration equation ("intended courses") was also added. In short, the model was designed to answer these questions:

> "Does SPI have any net effect on learning, enjoyment, or concentration?"
>
> "How do these effects... vary among students, i.e., does ... SPI differ systematically among definable classes of students?"
>
> "If SPI has any effect on achievement, enjoyment or concentrations, what is the mechanism through which it works?" (AER, p. 225.)

The somewhat disappointing result was that "The direct contribution of SPI to student happiness is insignificant and its contribution to concentration decisions is small." (AER, p. 225.)

Although the first year of the experiment produced "both remarkably happy students and a very high proportion of concentrators," the second and third years did not -- suggesting that the Hawthorne effect and heavy faculty involvement during that first year had been instrumental.

On the other hand, SPI did appear to improve performance (by about 15 percent) on a multiple choice final examination (made up of 10 TUCE items, 20 GRE questions, and 10 local items). SPI substituted for about 150 SAT points and 10 hours of weekly preparation by an instructor. In regard to the question of who derived the greatest benefit from SPI, Allison found that, in general, lower SAT groups and freshmen enjoyed a slight advantage over higher SAT groups and upperclass students. She concluded: "the marginal product of the well-prepared teacher is highest with the less brilliant student." (AER, p. 226.)

Why did some students do better in SPI? It was found that "...the crucial feature of SPI is the interaction between students and grader; that it is not just glorified homework but a very directed form of one-to-one instruction." Allison concludes: "We seem to have allowed our students to substitute efficient, interactive hours for passive or unfocused hours although apparently not to their great pleasure." She further asserts that "...moving to a SPI system brought about enormous improvements in our introductory course quite apart from its contribution to the learning of particular students." (AER, p. 227.)

Allison's work is deserving of considerable attention, both because of the findings of this study and the interesting research design she employed.

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Attiyeh, Richard E., G.L. Bach, and Keith Lumsden, "The Efficiency of Programmed Learning in Teaching Economics: The Results of a Nationwide Experiment," American Economic Review, May, 1969, pp. 217-223.

Over 4000 students in 48 schools were involved in this experiment in the use of programmed materials in the introductory college economics course. One group of students used programmed textbooks exclusively. A second used the programmed materials, but also attended conventional lecture classes and discussion sessions. The third group received conventional instruction and did not use the programmed books. Two programmed books were used, yielding different results. The group using these books exclusively did not do as well as the other two groups. In the group using one of these books as a supplement to conventional instruction, a statistically significant advantage was found. The other

book did not make a significant difference.

A major finding was that students spending an average of 12 hours studying a programmed text could learn about as much as those receiving seven weeks of conventional instruction. Furthermore, students using only the programmed materials performed better on questions calling for the application of theory than on simple "concept recognition" items, and had a positive attitude toward programmed learning.

Similar results were reported in "Factors Affecting Student Learning of Elementary Economics," Keith Lumsden, Ed., Recent Research in Economic Education. (Englewood Cliffs, N.J.: Prentice-Hall, 1970). Also see Keith Lumsden, "Technological Change, Efficiency, and Programming in Economic Education," in Keith Lumsden, Ed., New Developments in the Teaching of Economics (Englewood Cliffs, N.J.: Prentice-Hall, 1967, pp. 27-58, and his "The Effectiveness of Programmed Learning in Elementary Economics," American Economic Review, May, 1967, pp.652-659.

Questions about the Attiyeh, Bach, Lumsden study were raised by one of those authors, however. G.L. Bach, in "A Further Note on Programmed Learning in Economics," The Journal of Economic Education, Fall, 1969, Volume 1, Number 1, pp. 56-59, noted that the study had not included an adequate variable for the quality of the teacher. To explore this, an economics instructor at Stanford University who was noted for being one of the best teachers in the economics department was used in a controlled experiment. Students were given the choice of (1) using only the programmed textbook and not attending classes; (2) reading only the regular textbook and not attending classes; or (3) using the regular text and attending classes. The students learned a little more in the conventional mode than by using the programmed book only. Those studying the regular textbook did as well as those using the programmed material, suggesting the possibility that the students in the national experiment using the programmed text did well because they had to be self-reliant and not because of the superiority of the material itself. This, indeed, raises an interesting question for future research. If students do well in an independent study mode, is it because of the teaching strategy per se or because the students possess the quality of self-reliance and self-motivation?

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Bach, G.L., "A Further Note on Programmed Learning in Economics," The Journal of Economic Education. Fall, 1969, Volume 1, Number 1. Pp. 56-59.

(This study is also briefly described in the summary of the Attiyeh, Bach and Lumsden study above.)

Bach reports on a study comparing programmed teaching with results obtained by "an experienced, highly skilled teacher in a conventional classroom..." which was conducted at Stanford University during one quarter in 1969. The experiment dealt only with microeconomics, and the micro portion (Part A) of the Test of Understanding in College Economics (TUCE) was used. About 200 students were involved.

After three introductory classroom sessions, the students were allowed to choose from among the following:

1. Read the programmed text and do not attend classes.
2. Read only the regular textbook and do not attend classes.
3. Read only the regular textbook and attend classes.

Of course, those choosing 2 or 3 did not have to read the entire book -- only those portions on the relevant microeconomic topics. A week later the students took an identical examination and were told they would be graded on three separate curves so that they would not be penalized for choosing one scheme over another. About one third of the students chose each of the three alternatives. The grade point averages of the three groups did not differ substantially.

The conventionally taught students (No. 3 above) achieved a slightly higher mean score on the test than those in the other groups and spent somewhat more time on the course. Yet, Bach concluded that "programmed learning appears to be a very efficient means of learning the core of economic analysis, especially in courses with average or below-average teachers." (P. 58.) However, he asserted that with a high-quality teacher in the conventional section "the comparative efficiency of programmed-learning-only for students vanishes." (P. 58.) The students in the conventional section found the week's work more interesting than did those in the programmed-learning section. In summary, there is a place for both programmed learning and high-quality classroom teaching, according to Bach.

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Becker, William E., and Michael K. Salemi, The Learning and Cost Effectiveness of AVT Supplemented Instruction: Specification and Misspecification of Learning Models. Minneapolis: University of Minnesota Center for Economic Education, 1976. (Paper for

presentation at the Midwest Economics Association Meeting, St. Louis, Missouri, April, 1976.) 25pp.

Becker and Salemi examine the self-paced audio-visual tutorial (AVT) approach in terms of its impact on quantity, cost and efficiency of student learning in a community college economic principles course. The following questions are raised:

> Can a learning model be specified, on the basis of formal theoretical and statistical grounds, within which learning can be examined in control-experimental groups?
>
> Is there a difference in the quantity of learning as measured by the TUCE between control and experimental groups?
>
> What influence does student classroom and study time have on learning?
>
> Is the learning produced in the experimental sections less costly to students than that produced in the control groups?

Six community colleges in two states were used. At each college the same instructor taught both a control group using his or her regular teaching method and an experimental group using David A. Martin's AVT package, Introductory Economic Theory. They found no difference between control and experimental groups in terms of gain scores (post-TUCE minus pre-TUCE). Further, student study time had little effect, and there was actually a negative correlation between pre-TUCE scores and student learning. There was no difference in the average cost of learning per TUCE point between the two groups.

One of the simple linear learning models used was as follows:

$$L = f\left[\overline{A},\ T,\ S,\ u\right]$$

L is Learning; A is Aptitude; T is Time input; S is Situation (physical learning plant); and u is Random error. The model says that learning is dependent (except for the error component) on the student's aptitude (A is a measure of human capital), time spent in class and in study, and the environment or situation in which the learning takes place. Such variables as age and sex were not included on the ground that their contribution would be reflected in A.

Although the experimental treatment had no differential effect on learning, there were significant differences in learning

across schools. The negative coefficient on pre-TUCE casts doubt on pre-TUCE as a measure of aptitude. Other researchers may want to pay particular attention to Section III of the paper. "Non Linear Learning Models and Correction for Simultaneous Equations Bias." Here Becker and Salemi study the implications of fitting the learning model set forth above, and discuss pre-TUCE as an aptitude proxy. They suggest that a simultaneous equation bias may account for the highly significant negative pre-TUCE coefficient estimates. The use of an instrumental variable procedure, such as two stage least squares (TSLS) is offered as an appropriate remedy. Now the TSLS pre-TUCE coefficient estimate becomes positive, and this is consistent with the assumption that pre-TUCE is a proxy for aptitude. Nevertheless, they still find no "discernible difference" between control and experimental group learning; and student time remains insignificant.

Next, they take up the gap closing model. The "gap" is the difference between a perfect score and the student's pre-test score. It is the distance the student must close to achieve a perfect score on the post-test. The student's pre-test score is then deducted from his or her post-test score, and this amount is divided by the gap. The result is the percentage of the gap actually closed by the student. For example, if a student needs to gain 10 points to close the gap between his pre-test score and a perfect score, and he actually gains only 6 points, then his gap-closing score is 60%. (For an analysis of the gap closing model see Frank W. Gery, "Is There a Ceiling Effect to the Test of Understanding in College Economics?" in Arthur L. Welsh, Ed., Research Papers in Economic Education. New York: Joint Council on Economic Education, 1972, pp. 35-49.) With this measure of learning -- the percentage of the gap closed -- there is a positive relationship between pre-TUCE and student gain. However, Becker and Salemi assert that the gap closing model is misspecified in at least one way. The model predicts that the change score will be positive for all students, but this fails to account for guessing. Thus, a student might score higher on the pre-TUCE than on the post-TUCE.* Becker and Salemi dealt with this by dropping those cases for which the change scores were negative. The coefficient of pre-TUCE was significantly positive when estimated by TSLS. They urge that "future research ... strive to collect data which will give information on the aptitude of students in economics to use either as a replacement for pre-TUCE or as an instrument for it." (P. 17.)

There was little difference between control and experimental groups in terms of learning, and student study time was similar for both. Thus, the added cost of the Martin material might not be justified. However, the opportunity cost of student time differed

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*Several of my own research projects support Becker and Salemi here. -- George Dawson.

because the money value of that time (as measured by the wage rates earned by working students) varied. The student cost of learning was less for the experimental group, and this offset all additional fixed costs of the Martin package. The average weekly student cost of learning per TUCE point, however, was not statistically different.

In conclusion, in both the linear and non-linear model specifications, Martin's AVT package was not found to be superior in increasing economic learning, and student classroom and study time did not prove to be a significant input. The pre-TUCE effect on learning was positive when properly estimated by TSLS. The authors do not find the added cost of Martin's material to be justified. They assert that their study provides "a sound statistical modeling procedure which previously has not been attempted in economic education." (P. 21.)

(See the Walstad study, described below, which is closely related to this one. The Tolles and Ginman study, summarized below, also deals with Martin's AVT package.)

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Billings, Donald B., P.S.I. versus the Lecture Course in the Principles of Economics: A Quasi-Controlled Experiment. Unpublished paper. Boise: Boise State University, 1974.

At Boise State University, Billings experimented with self-paced instruction in a one-quarter introductory macroeconomics course. An examination was prepared, using items from the Test of Understanding in College Economics (TUCE), and was administered to the 31 experimental and 45 control students. The control group covered the same material, but the conventional lecture method was employed.

After controlling for ability and age, Billings found no significant difference in performance on the test. He also tried several models in an effort to investigate the correlates of achievement and possible interactions of student characteristics -- class standing, sex, ACT scores, math scores, attitude toward the course, and number of units mastered -- with self-paced instruction. He concluded that the regression equations offered "few statistically significant insights" and that "it appears that all kinds of students can find it a rewarding experience." (As quoted by Elisabeth Allison in "Self-Paced Instruction: A Review" in The Journal of Economic Education, Fall 1975, p. 6. Since we were unable to obtain

a copy of Billings' paper, we have relied upon Allison's summary for the above outline of his study.)

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Booms, Bernard H., and D. Lynne Kaltreider, "Computer-Aided Instruction for Large Elementary Courses," The American Economic Review. May, 1974. Pp. 408-413.

This study deals with the development of a Computer Generated Repeatable Testing system (CGRT), as one means of dealing with the problems presented by large enrollments. It is similar to Allen Kelley's TIPS, which is described below. (See Kelley, "Individualized Education through the Use of Technology in Higher Education." Indeed, the reader may wish to read the summary of Kelley's study first, since TIPS predates CGRT.)

CGRT is a teaching-testing system implemented by computers. The tests not only monitor student performance but serve as part of the learning process. Administered weekly, the tests (which are generated by computer) are used in conjunction with tutorial services rendered by graduate assistants. Students may repeat tests, and the highest grade is the one that counts. (Note that in Kelley's TIPS the tests -- or "surveys," as Kelley calls them -- are not used for grading purposes.) Students schedule their examinations, set their own pace, and receive tutorial assistance when they want it.

Each exam covers the material in the relevant instructional unit and is prepared by computer from a question bank of 4000 multiple-choice items. Each test contains 15 questions. The computer also provides answers, comments, and textbook page references for each item. Immediate feedback is provided for the student and the grades are recorded. The system is relatively expensive, however. It was estimated that each test cost $0.147, as compared with $0.11 for conventional examinations. (Preparation costs, paper, printing, supplies, secretarial services, processing and recording were taken into account.)

The Test of Understanding in College Economics (TUCE) was administered on a pre- and post-test basis. The CGRT students did 23.5 percent better than the national norm group. (Simple gain scores were used here -- the difference between pre-test mean and post-test mean.) The course also received favorable ratings from the students, 85 percent saying they would recommend it to other students. Over 82 percent said that the computer format was a good or excellent method of teaching. Nearly 90 percent

found the immediate feedback to be very helpful, and 90 percent considered the repeating of tests to be worthwhile learning experiences.

An effort was made to determine the lasting effects of the system by administering the TUCE a year later. Over 70 of the CGRT students (out of the original 320 at the University of Pennsylvania) took the test again, revealing that some erosion had occurred. The original gain score had been 6.87 points. The new gain score was only 3.91 points, a decline of 56.8 percent. (My own computations based upon figures in Table 3, p. 412, indicate that these students knew 68 percent of the material on the TUCE at the end of the course, and one year later they still knew 56 percent of it.) Eighty-seven percent of the students still considered CGRT to be a good or excellent method of teaching, one year after having been exposed to it. The tutors were of the opinion that they learned more (but worked harder) under CGRT than they did in regular recitation sessions. (See the Siegfried and Strand study, below, for a more systematic analysis of the impact of a similar experience on the tutors.)

The authors conclude that CGRT holds great promise and that it can be adapted to individual students' needs, even to the point of becoming totally student-paced. They recognize, of course, that further research is needed.

(This study is also described in Bernard H. Booms, "An Experiment in Computer-Managed Instruction," in George G. Dawson, Editor, Economic Education Experiences of Enterprising Teachers, Volume 10. New York: Joint Council on Economic Education, 1973. Pp. 86-91. A more complete report, including test items on computer print-outs, details of testing procedures, cost comparison data, the evaluation questionnaire, and statistics on the formal testing can be obtained from the Ohio University Library, Economic Education Awards Materials, Athens, Ohio.)

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Bostow, Diane, and G. Hartley Mellish, The Effect of Remediation on the Performance of Principles of Economics Students Using Programmed Materials. Unpublished paper. Tampa: University of South Florida, 1974. 16pp.

This study is not the usual comparison of the performance of students using programmed materials with those using some other means of instruction. Rather, it deals with one aspect of many courses in which some sort of self-paced instruction is employed.

That is, students may often retake a test if they have not achieved a satisfactory score. In an earlier study, Bostow and Connor required students to "remediate" weekly quizzes when scores fell below 90%. Comparing these students with others who could not take the tests again, they found that the "remediation" group did better on the first exam. (See D. Bostow and R. O'Connor, "A Comparison of Two College Classroom Procedures: Required Remediation versus No Remediation," Journal of Applied Behavior Analysis, 1973, pp. 599-608.)

At the University of South Florida in 1974 economics students using a programmed text were randomly divided into two groups. Group A students were required to remediate each weekly test if scores fell below 90%. Group B could not retake the tests, so Group A did better. However, there were also differences in frequency of testing. To conduct a study in which remediation would be the only independent variable to change, the researchers divided economics classes randomly into two groups -- X and Y -- which would experience the same conditions except that X students could remediate during weeks when Y students could not. Thus, the techniques of multiple baseline and reversal were employed. For example, X could remediate tests 1, 2, and 3, while Y could not. Then Y could remediate tests 4, 5, and 6, but X could not. Reversal, wherein each group experiences both treatments, makes it possible to have a within-group comparison of the effects of both treatments. The multiple baseline technique reduces the possibility that accidental variability will affect the research. The problem of contamination which is common in experimental vs. control group designs was avoided.

Students took a multiple choice test during the first class meeting of each week. Those scoring below 90% took the test again two days later, plus a few short essay questions. It was thought that students might not bother to do well on the first test if they knew they would have a second chance. This was unfounded, however. The researchers asserted: "...we must assume that students' initial test performance is not affected by the presence of the remedial opportunity." (P. 7.) The majority of those who remediated, however, did improve their knowledge of the material. This occurred even when alternate test items were used in place of items identical with those on the original tests. Indeed, "more students improved on the remedial test when the items were completely different." (P. 8.) The authors conclude that: "There is evidence to believe now that students perform better on remediation for some reason other than just postponing the studying they could have done for the first test." (P. 8.) They urge further research to see whether students who have been able to remediate perform better on final exams.

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Buckles, Stephen G., and Marshall E. McMahon, "Further Evidence on the Value of Lectures in Elementary Economics," The Journal of Economic Education. Spring, 1971, Volume 2, Number 2. Pp. 138-141.

Although the Buckles-McMahon study does not concentrate on personalized, self-paced, or individualized instruction, it has been included here because it did involve the use of programmed material. Furthermore, personalized instruction often implies the absence of lectures, and this study may shed some light on whether or not the abandonment of lectures has serious consequences.

First, the authors criticize some of the techniques used in other studies. (They refer to the studies by Attiyeh, Bach, and Lumsden, by Bach alone, and by McConnell and Lamphear, reported elsewhere in this booklet.) One "weakness," according to Buckles and McMahon, is allowing students to select the method of learning (see Bach for an example of this) because they might select techniques under which they learn better and thus bias the results. A second weakness is the use of examinations written by the instructors involved, for this enables them to stress material on the test in their lectures. Further, they do not believe that a textbook written by a teacher involved should be employed. Finally, they assert that "only one aspect of teaching should be tested. For example, the use of a programmed text alone should not be compared to lectures accompanied by a conventional text, as the researcher is not able to isolate the effects of the conventional text as opposed to the effects of the lectures." (P. 139.)

The experiment reported here was conducted during the first two weeks of the second semester of a two-semester introductory course, and involved two sections taught by different instructors. During four class periods the material covered by the text was "elucidated." Then, in each section students were randomly divided and assigned to the control group (attending lectures and using the programmed text) and the experimental group (not attending class but reading the programmed text). The groups were graded on separate curves. The micro portion of the TUCE was used as a pre-test, with the results used as an independent variable indicating the economic knowledge each student brought to the course. The post-test was made up of items provided by the Joint Council on Economic Education from its test question bank, according to the specifications of the researchers. The instructors did not see this test before it was administered.

Regression analysis indicated that lectures did not improve student performance, leading to the conclusion that "class lectures which do no more than recapitulate the assigned reading do not aid the student in learning elementary microeconomic theory." (P. 140.) The number of hours spent in studying the programmed text was not significant, nor was the section in which the student had been

placed. The TUCE post-test was administered at the end of the semester, but this did not show that lectures had added significantly to the students' learning of economics either. Thus, lectures did not have a greater residual impact (lasting effect) than the other mode of instruction. Buckles and McMahon are not implying that lectures should be eliminated, however. Note the qualifying statement "lectures which do no more than recapitulate the assigned reading." They believe, rather, that lectures might be replaced by discussions of applications of economic theory. They recognize, too, that more research is needed, because their data applied only to about 160 students in one university (Vanderbilt). In their concluding comments they state that "it would be of immense value to determine what kinds of students do best under which alternative teaching methods. Perhaps then education could be individualized at even the largest universities." (P. 141.)

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Calvin, Allen D., "Programmed Instruction in Economics," in Keith G. Lumsden, Ed., New Developments in the Teaching of Economics (Englewood Cliffs, N.J.: Prentice-Hall, 1967), pp.59-64.

Calvin reports on a study conducted by R. Bryce Young at Foothill Junior College in Los Altos Hills, California. The college offered a course called "Business Economics" which attempted to cover in one semester the areas covered in the conventional two-semester university course in principles of economics. A group using a standard textbook and getting conventional instruction was compared with another group using programmed material developed by Attiyeh, Lumsden, and Weiner (The American Economics Series published by Behavioral Research Laboratories of Palo Alto, California, in 1963 and 1964).

The experimental group did not hear lectures, but did attend regularly scheduled classes to take review tests and discuss individual problems with the instructor. There was no significant difference between the two groups in terms of median scores on the American College Testing Program Entrance Examination (Chicago: Science Research Associates, 1964). Science Research Associates' Test of Economic Understanding was used for pre- and post-testing. The mean improvement of the experimental group was more than double that of the group using the conventional text. According to Calvin, "An analysis of variance indicated that the improvement was significant and attributable to the method of instruction." (P. 63.) Furthermore, the group using the programmed materials did significantly better than the national norm group for the TEU. Finally, the control group did no better on the instructor's own final

examination than did the experimental group. Thus, Calvin concluded that "programmed textbooks can be an extremely valuable tool in the teaching of economics." (P. 63.)

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Craig, Eleanor D., and James B. O'Neill, The Advantages of the Humanistic Approach in Teaching College Economics (Newark, Delaware: The Bureau of Economic and Business Research, College of Business and Economics, University of Delaware, 1974), 17pp.

After comparing several course formats in introductory macroeconomics, Craig and O'Neill concluded that "The more that the student was involved in his own learning process through self-instructional techniques and individual options for projects, the more he perceived that he learned, the more he enjoyed the instructor, and the more favorable changes occurred in his attitudes toward the subject matter." Five classes of about 30 students each were tested with the TUCE and a departmental final, and filled out attitudinal questionnaires. Two classes were taught by "Instructor A," who used the Sterling Institute's Economic Analysis programmed materials, Volumes 1, 2, and 3.* Current readings were also assigned, and there was "frequent testing." Instructors B and C used a more traditional textbook, handouts, and supplementary readings. Optional independent activities included a computer game, trips to Washington and New York, debates, book reports, case studies, papers, and other individual projects.

The TUCE was used as pre-test and post-test in all classes, revealing no significant difference in gain scores. There was no significant difference in performance on the departmental final, and there was a high correlation between performance on that test and on the TUCE. (The students were found to be similar in terms of SAT math and verbal scores, and in terms of grade point indexes.)

Significant differences were found in attitudinal response. Students who had options for outside activities appear to have developed "a keener interest in the discipline." (P. 7.) The authors assert: "The more positive attitudes throughout the semester for instructors B and C seems to have been generated by the greater student involvement in the learning process." (P. 12.)

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*For other studies of the Sterling materials, see Mellish and Bostow below, and Soper and Thorton below.

Craig, Eleanor D., and James B. O'Neill, "The Predictability of Retention in Economics," The Journal of Economic Education. Spring, 1976, Volume 7, Number 2. Pp. 92-94.

Students taught by conventional methods (a standard introductory macroeconomics textbook plus a book of case studies) were compared with those using self-instructional materials. Again, the TUCE, a departmental final, and an attitudinal questionnaire were used. (See Craig and O'Neill, above.) Although they had found no "cognitive level differences," Craig and O'Neill thought that students who had more positive attitudes toward the course might retain the material longer. Their hypothesis was confirmed.

The population tested included students who had taken traditional courses and self-instruction courses two years earlier and one year earlier. Some students had since taken additional economics courses, and the mean score on the "Retention TUCE" was 17.7 as compared with 15.6 for those who had taken only the introductory course. A factor summarizing positive attitudes toward the course explained eight percent of the variability in retention. The self-instructional method accounted for another two percent, but this was statistically significant.

The TUCE items are categorized as "Recognition and Understanding" questions, "Simple Application" items, and "Complex Application" items -- the latter being the most difficult. Craig and O'Neill found no significant differences in retention between the self-instructional and traditional classes in any of these cognitive areas for all students in the sample. However, with students who had taken the introductory course only, there was a relationship between time elapsed since the course was taken and the method of instruction. Both methods produced the same level of retention for students who had taken the course one year earlier. But for students who had taken the course two years earlier, the mean retention on Complex Application items was 16 percent higher for those who had been exposed to the self-instructional method. (See Attiyeh, Bach, and Lumsden, above, for a similar finding.) Craig and O'Neill concluded that "people remember things which interest them." They assert that: "When post-TUCE performance and verbal ability were discounted, attitudinal interest was the next most important variable in predicting retention results." (P. 94.)

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Darnton, Donald C., "Programmed Learning-Policy Analysis: An Experiment in Teaching Principles of Economics," The Journal of Economic Education. Fall, 1971, Volume 3, Number 1. Pp. 32-35.

Virginia Polytechnic Institute participated in the nationwide study of programmed learning conducted by Attiyeh, Bach, and Lumsden (described above). Seeing that their own results agreed with the nationwide findings, VPI decided on further experimentation with programmed instruction. A group of 42 students in a three-credit introductory macroeconomics course made up the experimental section. They did not attend regular classes, but met to take weekly tests (multiple-choice and essay), and could meet with Darnton on an individual basis to discuss their progress.

Darnton asserts that the "substance of macroeconomics" was covered in four weeks, after which the students worked on position papers involving different economic policy issues. The experimental students reportedly devoted less time to the course, as did the instructor. Part One of the TUCE was administered on a pre-test, post-test basis to the experimental and two control sections, with the result that the experimental students did just as well as those in the control groups and in the national norm group. They did better, however, on the complex application type of questions, while the controls and the norm group did best on the recognition questions. Darnton explains this by saying: "Conventional texts contain far more descriptive and institutional material than do programmed books, and this information is better tested by questions requiring recognition than application. The policy analysis papers written in the experimental section should have helped students to apply the theory they had learned, and so probably prepared them for those questions requiring more complex application of analytical tools." (P. 33.)

The method proved to be popular with the experimental students (all of whom had previously been exposed to conventional instruction in economics), their evaluations being "overwhelmingly favorable." (P. 33.) While Darnton does not suggest that the programmed text plus policy analysis approach replace all others, he does argue that his experiment confirms "that it may be one of several viable methods of teaching principles of economics" (p. 33) and that it has "sufficient merit to add it to the variety of teaching methods used in the principles course." (P. 34.)

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Fels, Rendigs, "The Vanderbilt-JCEE Experimental Course in Elementary Economics," The Journal of Economic Education. Special Issue No. 2, Winter, 1974. 94pp.

The experimental course at Vanderbilt involved the adaptation of the case method to economics instruction. Several years were spent in developing the course and testing its effects. An attempt was made to promote student mastery of economic principles through a combination of the case method with Keller's self-paced P.S.I. In place of lectures, the students get an assignment which they study with the help of a proctor, then take a test when they think they are ready for it. Complete mastery is expected before the student goes on to the next assignment, and grades depend upon the number of assignments completed. Students know what they have to do to achieve an A, B, or C grade, and incentive is high. Students work at their own pace, having personal contact with instructors when needed. Students may earn up to 80 points during the semester and up to 20 more on the final exam. One must earn 90 points for an A, 80 for a B, etc.

For each of seven sections of the principles course there is a written test on basic concepts. This is worth four points. The concepts are those which the student must know in order to analyze economic issues and cases. The seven tests are in the study guides and students must pass each with 100 percent correct. There is also an analytic test for each of the seven sections, also worth four points. Sample questions, but not the actual test items, are available to students in advance. Students may take these tests either in written or oral form. The latter form is considered "a powerful method of teaching." (P. 7.) Students earn 56 points by passing the basic concepts and abstract analysis tests, and they must do this to pass the course.

Students also earn points by passing tests on policy cases. (See Rendigs Fels and Robert G. Uhler, Editors, Casebook of Economic Problems and Policies. St. Paul: West Publ. Co., 1974,75.) They study a case (such as the economics of an all-volunteer army), develop their own positions on the issue, write it up, and have their essay evaluated. If the essay is deemed "excellent," the student goes on to a new case. They may earn up to 24 points in this manner.

Departing somewhat from the usual P.S.I. procedures, Fels retained a conventional final examination. He believed that by reviewing for the final the students would reinforce their learnings and perhaps retain the material longer.

Preliminary evaluation, while limited, was favorable enough to encourage continuation of the experiment. The results are set forth in the study by Siegfried and Strand, described below. (Pp. 9-26.)

(If the preliminary findings are of interest, or if readers wish to examine other related studies by Fels, see the following:

Ben Bolch, Rendigs Fels, and Robert Uhler, An Experiment with Self-Paced Instruction. Unpublished paper. Nashville: Vanderbilt University, 1972. (Self-paced instruction was used in a basic Macro course in conjunction with a programmed text. The performance of the 27 experimental students was compared with that of 109 control students on the TUCE and the CLEP. No significant difference was found.)

Rendigs Fels and Dennis R. Starleaf, "Controlled Experiments in Teaching Techniques." Southern Economic Journal. July, 1963. Pp. 68-73.

Rendigs Fels, "Developing Independent Problem-Solving Ability in Elementary Economics." American Economic Review. May, 1974. Pp. 403-407.

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Fusfeld, Daniel R., and Gregory Jump, "An Experiment with Programmed Instruction in Economics." The Southern Economic Journal. January, 1966. Pp. 353-356.

In one of the earliest experiments with programmed instruction, Fusfeld and Jump at the University of Michigan evaluated the effect of programmed materials on learning supply and demand. The materials were used during the first week of the second semester of the introductory principles course. The normal procedure was to have students attend a one-hour lecture and three one-hour discussion sessions each week. In this experiment, two discussion sections were excused from classes for one week and were told to study entirely on their own, using programmed material. The same test was used both for pre- and post-testing. Students kept logs on the time spent in studying.

The two control sections were taught by the same instructors responsible for the experimental sections. Students were told they were part of an experiment and knew they would be tested after one week. (The test was made up of 20 true-false and five completion items taken from the programmed material and the workbook used in the course.) The post-test was to count as part of the students' final grade. The basic questions posed by the researchers were:

(1) Can students learn as much from independent study using programmed materials as from conventional instruction?
(2) Does the textbook make a difference when used in conjunction with programmed material?
(3) Is learning improved when students are aware that an experiment is being conducted and that they will be tested?
(4) Does independent study save time for students and/or teachers?

The pre-tests revealed no significant differences between groups. The post-test likewise showed no difference, indicating that programmed instruction was as effective as the conventional method. When used in conjunction with programmed material, the textbook added nothing to student achievement. Student awareness of the fact that they were part of an experiment and that they would be tested did make a significant difference in their learning. (Two "secondary control sections" had been set up, consisting of students who were not told they were part of an experiment and were not told that a test would be given at the end of the week.)

The data were also broken down by bright, average, and poor students. The lower third showed the largest improvement; the top third showed the least. This was to be expected on a test with an upper limit. More importantly, however, when the bright, average, and poor students were compared across groups (experimental and control) it was revealed that the programmed students did as well as their peers in the control sections.

Finally, the programmed students spent less time in studying, but learned as much as their colleagues in the conventional sections. Fusfeld and Jump recognized the fact that they were dealing with small samples (about 70 students altogether), but concluded that independent study can be as effective as conventional instruction while saving time for both students and instructors.

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Gordon, Sanford, "Optimizing the Use of Televised Instruction," The Journal of Economic Education. Fall, 1969, Volume I, Number 1. Pp. 46-50.

Gordon reports on an experiment in which three modes of instruction were compared at the State University of New York at Oneonta. In addition to a conventional lecture-discussion section,

one group of 25 students received basic economics instruction through television, followed by ten or fifteen minute discussions led by a senior student. A third group of 25 students worked individually in study carrels, using 8mm film cartridges and setting their own pace. Students in the different groups were matched in terms of regents scholarship exam scores, sex, and academic major. On the midterm and final examinations, 14 of the students in the individual study group achieved higher scores than their counterparts, while 11 in the TV group had higher scores. The differences were not statistically significant, however. Gordon noted that further research was needed, but concluded: "If our product, the introductory course, is to meet the needs of our consumers, the students, we must recognize their differences and vary our offering to meet their changing demands." (P. 50.)

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Hanni, Eila, The Grade Incentive as a Systematic Variable in the Comparison of Conventional vs Behavior Managed Learning of Principles of Economics. Unpublished paper. Tampa: University of South Florida, 1975. Pp. 12.

This study involves a comparison of programmed learning and the conventional lecture-discussion approach at the University of South Florida. (See the Mellish-Bostow study, summarized below.) Hanni hypothesized that the incentive offered to students taking the test was more important than differences in teaching methods.

In the experimental group the students were tested at least once a week and were required to re-take tests when performance was below mastery level. This group rarely attended lectures. The students received behavioral objectives at the beginning of the quarter, and their grades depended upon a point system. The control group students were tested infrequently, were not allowed remediation, and attended four lecture sessions per week, often accompanied by class discussion. These students received a conventional syllabus and were graded on a curve. A multiple choice examination was administered at the end of the quarter to both groups. Most of the questions were taken from the TUCE.

There was no significant difference between the experimental and control groups. That is, the programmed approach was as good as -- but no better than -- the conventional method. It does make a difference, however, if the test used to compare groups counts toward the student's course grade. Hanni notes that "Norms have been developed without motivation for the test being explicitly

recognized as a contributory factor.... In major undertakings, such as the preparation of the TUCE tests, no uniform motivational framework was set up." (P. 5.) This is an important observation. The Manual for the TUCE points out (p. 13) that about one fourth of the instructors administering the TUCE to collect norm data used the test as part of their final examinations and that the effect of this on the scores is not known. The instructions issued to those participating in the norming of the TUCE were to tell the students that their scores would be used to develop national comparisons and that their results would be compared with those from other schools. Hanni argues that "more meaningful comparisons of student performance in conventional vs behavior managed learning situations are obtained if standardized, validated tests are used in both cases and the contribution of this test to the overall grade is employed as an independent variable." (P. 7.) Hanni's regressional analysis showed that the weight assigned to the test used to compare experimental and control groups was a significant determinant of the student's final test score. The basic conclusion is that "there is a need to develop testing situations, and especially norming situations, where a grade incentive is present and controlled for. Norming situations that rely on the willingness of the students to work for the benefit of 'future generations of students' defeat their purpose. ...If a considerable portion of the course grade depends on the result of the final test, student performance will be good; However, if the test will have little or no effect on the course grade, student performance will drop off." (P. 12.)

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Havrilesky, Thomas, "A Test of the Effectiveness of Teaching Money and Banking by Programmed Instruction," The Journal of Economic Education. Spring, 1971, Volume 2, Number 2. Pp. 151-154.

Havrilesky's study differs from most others in that it deals with money and banking rather than the introductory micro or macro course as a whole. The programmed text used deals with money and banking, whereas most other experiments used programmed materials in basic principles of economics.

The 36 students involved in the study were taking a macro course at Duke University. All were sophomores, and all had had ten weeks of conventional instruction which excluded monetary theory and money and banking. The experimental group of 15 students was required to do 11 short chapters of programmed instruction during a one-week period. The 21 control students received conventional instruction, attending three class lectures and one individual

tutorial session with the instructor. They read several chapters in standard textbooks.

Each group took a pre-test made up of 12 questions in monetary economics taken from the TUCE and four items prepared by the instructor. (The instructor was the same for both groups.) Each group was graded on a separate curve. There was no significant difference between groups in terms of pre-test mean, grade point average, SAT total score, cumulative class grade, and hours devoted to study during the week. The programmed group achieved a higher mean score on the post-test, however, and the difference was significant at the .005 level. An ordinary least squares regression analysis revealed that the use of programmed instruction, grade point average, and cumulative grade in class were significant at the .05 level. The use of programmed instruction increased the post-test grade by 8.7 percent.

Havrilesky suggests the possibility that programmed instruction has a comparative advantage for short periods, but that the advantage might decline as the time period in which it is used increases. Programmed instruction might generate self-reliance and cause students to work harder, and perhaps they "generally work well with programmed materials." (P. 154.) Contrary to some other researchers, Havrilesky thinks that programmed learning works well with the better students, but he asserts that all students in his study benefited. Finally, he concludes that "programmed instruction excels for core learning over equal, short periods of application." (P.154.)

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Kelley, Allen C., "Individualizing Education through the Use of Technology in Higher Education," The Journal of Economic Education. Spring, 1973, Volume 4, Number 2. Pp. 77-89.

While teaching the introductory economics course at the University of Wisconsin (Madison), Kelley became concerned at the "depersonalization" caused by large enrollments. Thus, he developed his Teaching Information Processing System (TIPS) as a means of providing some sort of individualization within the context of large lecture courses. The problems are well known -- professors go too fast for some students, too slow for others. Frequent feedback is lacking, and when students do get some sort of indication of how well they are doing it may be too late to correct deficiencies easily.

Kelley's TIPS combined the results of weekly multiple-choice surveys (he declines to use the term "exam") with data about the

students, such as his or her aptitude and achievement test scores, math background, and previous performance. Student strengths and weaknesses are identified and matched to alternative assignments which are reported on a Student Report Form. The student receives an assignment tailored to his or her instructional needs. For example, a student might receive an optional assignment on a concept already understood and a required assignment relating to something not well understood. A student with a strong math background might get an assignment that would enable that individual to utilize that background on the economic topics. Students who do very well may get special assignments, such as attending a special discussion section or reading material on a current economic issue. The surveys will also indicate whether or not a student needs tutorial assistance.

The professor also gets feedback on the class as a whole, enabling him or her to concentrate on weaknesses. How is all of this done? Since the professor cannot know a large number of students personally, a computer processes the surveys and generates the specific assignments. The surveys are not used for grading the students, hence Kelley's reluctance to call them tests. The following examples will illustrate the use of the surveys:

(1) Mr. W. achieves a perfect score on a survey. Instead of the regular class assignment, he receives a special handout which goes beyond the regular course presentations. He is also invited to attend an intermediate course session. All of this is explained in the computer print-out which reports to Mr. W. the results of the survey. The print-out even contains a touch of humor -- "Congratulations -- you obtained a perfect score. You are either extremely bright, or just plain lucky." (P. 85.)

(2) Mr. J. did not do as well as Mr. W. He missed two of the ten questions. The computer tells him which items he missed and tells him where to look for the correct answers. He is also told to attend a special discussion session. The computer "knows" that Mr. J. has a strong background in math, so he is assigned to a section in which mathematical techniques will be used in developing the economic concepts.

(3) Poor Mr. T. answers only three of the ten items correctly. He is then provided with special materials which are simpler than the basic textbook, and he is told how to learn the concepts he missed through the study of a programmed textbook.

The system is fast and efficient. The surveys take five to ten minutes to complete, and the students receive their Report Forms within four to ten hours. The professor and the teaching assistants also receive Report Forms. Thus, the teaching assistants quickly

learn which concepts are being grasped by their students and which need reinforcement. The professors get the same kind of feedback for the class as a whole.

Several evaluations of TIPS have been made. Students in TIPS sections were the experimentals; students getting conventional lecture-discussion instruction served as controls. Those in the control group received identical assignments, while TIPS students received assignments geared to their problems, backgrounds, and abilities. There were about 250 students in each group. Identical texts were used, and the two groups proved to be similar in terms of aptitude, prior academic achievement, academic major, class, and math background. The same mid-term exam was administered to both groups (at the same hour).

Through regression analysis, with controls for such variables as class, major, ACT and SAT scores, pre-test scores (using the TUCE), sex, math background, and section leader, it was found that TIPS increased examination scores by about 15 percent for the average student. The benefits of TIPS were not evenly distributed, however. Low achievers (as measured by ACT and SAT) gained most from it, their test scores increasing by 19 percent. High achievers gained about 13 percent. Thus, while all derived benefit from TIPS, its greatest impact was on the poorer student.

Kelley also did a lasting-effects study, retesting students after one year. This revealed that the TIPS students maintained their superiority over time, although its magnitude diminished. The proportion of TIPS students selecting economics as a major was 23 percent higher than that of the controls. Yet, the TIPS group did not give the course or the instructor a higher rating, nor did they enjoy the course more than the control students. Kelley feels that further evaluations are needed, although TIPS is now being used in 70 different universities and informal reactions are highly favorable.

For other reports on TIPS see the following:

Herbert G. Grubel and Allen C. Kelley, TIPS and the Use of Computers in Teaching Economics: The Experience of Simon Fraser. Unpublished paper. Durham, North Carolina: Duke University, 1974.

Allen C. Kelley, "An Experiment with TIPS: A Computer-Aided Instructional System for Undergraduate Education," American Economic Review. May, 1968. Pp. 446-457.

Allen C. Kelley, "The Economics of Teaching: The Role of TIPS," in Keith G. Lumsden, Editor, Recent Research in Economic Education. (Englewood Cliffs, N.J.: Prentice-Hall, 1970.) Pp. 44-66.

Allen C. Kelley, "On the Appraisal of Technical Change in Classroom Instruction," in George G. Dawson, Editor, Economic Education Experiences of Enterprising Teachers, Volume 10. (New York: Joint Council on Economic Education, 1973.) Pp. 78-85.

Allen C. Kelley, "TIPS and Technical Change in Classroom Instruction," American Economic Review. May, 1972. Pp. 422-428.

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Kelley, Allen C., and Caroline Swartz, "Student to Student Tutoring in Economics," The Journal of Economic Education. Fall, 1976, Volume 8, Number 1.

Kelley's TIPS, in which computers are used to help individualize instruction, is described in the report immediately above. This study reports on an experiment in which student-to-student tutoring was added to TIPS in the freshman economics course at Duke University. Students who performed well on the TIPS surveys were offered exemption from an examination if they would tutor students who were having difficulty. The tutors had to attend a one-hour training session, hold group tutorials for three to six students, and be available for one-to-one tutoring.

Students having problems were invited, but not required, to attend tutorial sessions. About 18 percent of the class was so invited, and 11 percent did attend. Such self-selection raises questions about the extent to which the experiment was well-controlled, but a comparison of "background attributes" -- SAT scores, high school GPA, math background, and exposure to high school economics -- showed the students who rejected the invitation to be similar to those who accepted. Self-selection, then, probably didn't bias the results, unless self-selection indicates motivation. Kelley felt that self-selection very possibly did indicate motivation, and that this factor in combination with the tutorials explained the superior performance of the students who accepted tutoring.

All students took two mid-terms and a final, and were required to hand in five cases. Points earned on the tests and through the

cases were added to get total points for the course. All of the "background attributes" had a statistically significant effect on performance. The impact of the tutorial program was much greater, however, often raising student scores sufficiently to increase their course evaluations by a full letter grade. Furthermore, the cost of Kelley's tutorial program was low. (For the effect of tutoring on the economic learning of the tutor, see the Siegfried and Strand study summarized below.)

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Luker, William; Marianne Bonds; Watt Black; and Thomas C. Holland, "The Quasiexperimental Study of the Differential Impact of Four Delivery Systems on Economic Understanding," The Journal of Economic Education. Spring 1975, Volume 6, Number 2. Pp. 134-137.

The researchers measured the impact of four "delivery systems" on student knowledge of economics. The TUCE was employed to test the effect of games and simulations, closed-circuit television (the taping and playback of student presentations), programmed learning, and the conventional lecture-discussion approach. Over 100 students enrolled in a microeconomics course at North Texas State University were tested. They were randomly assigned to various groups. The students also completed questionnaires on how much they enjoyed each delivery system and how effective it was in preparing them for examinations.

A tutor was assigned to each group with instructions to use each delivery system one time. The students were tested before and after exposure to each system. The research design was a modification of Campbell and Stanley's quasiexperimental, counterbalanced design No. 11. (See Donald T. Campbell and Julian C. Stanley, Experimental and Quasi-Experimental Designs for Research, 8th ed. Chicago: Rand McNally, 1972.)

Our interest in this study stems from the fact that programmed materials were included, and programmed materials are often used in self-paced instructional programs. The researchers found that "There was no significant differential impact attributable to delivery systems on increased economic understanding." (P. 136.) They concluded, however, that "programmed learning is probably more effective if students recognize its value." (P. 137.) They did find "a significant interactive relationship between increased economic understanding and the degree to which students using programmed materials perceive programmed learning as worthwhile in preparing for tests." (P. 136.) On the other hand, programmed learning was not as popular as the other systems. The order of preference was

(1) games and simulations, (2) lecture-discussion, (3) closed-circuit TV, and (4) programmed learning. A final conclusion was that a multiple set of delivery systems can be used, "with the most effective combination being programmed learning and games and simulations." (P. 137.)

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Lumsden, Keith, "The Effectiveness of Programmed Learning in Elementary Economics," American Economic Review, May, 1967. Pp. 652-659.

Lumsden reports on several studies measuring the effectiveness of programmed learning in microeconomics. These involved students at Yale, Stanford, the University of California at San Diego, Wesleyan, the University of Illinois, and Marin College.

The first two experiments involved about 100 students at Stanford who had not had economics before in college and about 130 sophomores at San Diego who had taken introductory macro. The classes were split into three matched groups called A, B, and C. Students in A received programmed material and were told to use this exclusively. Those in B were taught in the conventional manner, using their regular textbooks and attending lectures covering the same material. The C group studied the regular basic textbooks only (the same as those used by B). All students could attend question sessions and consult the professor and the teaching assistants. At the end of one month all took the same examination, made up of true-false and essay questions. The group A students achieved significantly higher scores. (There was no difference on the objective part of the examination, however.) All students then received conventional instruction and a common examination at the end of the course. Group A students again outscored B and C on the final examination. Lumsden could not be sure, however, whether programmed instruction accounted for group A's superior performance or they were superior to begin with.

In a slightly different experiment at the four other schools, sections were randomly selected from the introductory classes. The experimental group studied the programmed text only; the controls used conventional texts and attended classes. All took the same test after four or five weeks. The test was made up of multiple-choice items from workbooks. A simple regression analysis was made, with test score as the dependent variable and treatment group and intellectual capacity as independent variables. At Marin College the control students did significantly better, but at the other three

colleges there was no difference between groups. (Marin is a junior college.) When adjustments were made for time spent studying there was no significant difference between the programmed and non-programmed sections. Lumsden cautiously concluded that independent study through programmed instruction can be as effective as conventional teaching (at least for learning price theory) and that it saves time for both teacher and student. The programmed sections spent much less time in studying (less than half as much at the University of Illinois), but learned as much. Finally, of the 500 students who responded to questionnaires on their preferences, 49 percent chose programmed instruction, 26 percent selected the conventional, and the rest were indifferent.

(Also see the study by Attiyeh, Bach, and Lumsden, summarized above.)

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McConnell, Campbell R., and Charles Lamphear, "Teaching Principles of Economics Without Lectures," The Journal of Economic Education. Fall, 1969, Volume 1, Number 1. Pp. 20-32.

This is one of the early studies designed to answer the question: "Can today's college student...grasp the principles of economics without the aid of the classroom teacher?" (P. 20.) The authors compared the performance of students studying economics by closed-circuit televised lectures with a "lectureless" group. Over 400 students at the University of Nebraska were involved. Students in the first semester of the principles course were permitted to choose between the two groups, and 86 chose the lectureless section. The Omnibus Personality Inventory (OPI) was administered to both groups to see if those selecting the lectureless section had more autonomy or initiative. The OPI revealed no significant difference between them. Students in both groups used a conventional textbook, study guides, readings on current issues, and programmed material. The TV lectures were textbook-oriented. Ten tutorial sessions were held for each group under the direction of graduate assistants. Short self-tests were also prepared, enabling students to check their progress frequently.

To compare the performance of the two groups, several tests were administered. One was a 170-item examination designed especially for the Nebraska principles course. A second was the Test of Economic Understanding (TEU), designed for high school students but widely used in colleges before the development of the TUCE. A third was a 90-item test made up of questions supplied by

the committee that was creating the TUCE, referred to as the "Preliminary College-Level Examination" by the authors. Finally, they used Part I, Form A, of the TUCE (macro section).

On the Nebraska test, the lectureless group achieved a mean score three points higher than the control group, but this was not statistically significant. This test contained three types of questions -- factual, conceptual, and analytical. The lectureless group achieved higher means on all three types, but again the difference was not significant (.10 level). Similar results were obtained on the other tests as well -- the lectureless group doing better, but not significantly so. Both groups outperformed the national norm group on the TUCE, significant at the .01 level.

The data were also disaggregated in terms of student ability, as measured by cumulative GPA. It was expected that the poorer students in the lectureless group would suffer from the absence of lectures and thus do less well than their counterparts in the TV group. This was not the case, however, the lectureless students doing as well or better than those in the control section.

An attitude survey showed that the lectureless group gave a significantly higher rating (at the .001 level) to the instructional method, and had a slightly (but not significantly) more favorable attitude toward economics as a discipline.

Comparisons were also made between the lectureless group's performance and that of students exposed to live lectures in large and small groups during the previous year. Again the lectureless group did just as well. McConnell and Lamphear concluded that "pedagogical capital (study guides and programmed material) can be successfully substituted for text-oriented lectures...." (P. 31.) The student is forced to accept responsibility for his or her own learning when denied "professorial spoonfeeding," must take the initiative in the pursuit of knowledge, and becomes better prepared for life-long self-education. Furthermore, the authors feel, the gap between undergraduate and graduate education may be narrowed if students are required to work independently.

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Mellish, G. Hartley, and Diane Bostow, The Experimental Analysis of Learning Behavior in Principles of Economics. Unpublished paper. Tampa: University of Southern Florida, 1975. 9pp.

This paper reports on an experimental program involving a

modified Keller system, or personalized system of instruction. (See F.S. Keller, "Goodbye Teacher...." Journal of Applied Behavior Analysis, 1968, pp. 79-89.) The six programmed volumes of the text Economic Analysis (Washington, D.C.: Educational Technology Corp.)* were used at the University of South Florida with over 1300 students in 1974-75. The authors' experiment with remedial testing has already been reported. (See Bostow and Mellish, above.) In addition, students in traditional lecture classes were compared with those using the programmed approach -- the Test of Understanding in College Economics (TUCE) being used for pre- and post-testing. The Karstensson-Vedder attitude survey was also used on a pre- and post-test basis. (See L. Karstensson and R. Vedder, "A Note on Attitude as a Factor in Learning Economics," The Journal of Economic Education, Volume 5, Number 2, Spring, 1974.) There was no significant difference in performance on the TUCE, but student attitudes toward economics improved in the experimental section (while those in the traditional sections declined), and the personalized method reduced cost per student by about 50%. Furthermore, students for whom English is a second language were able to perform "satisfactorily." Finally, there was a comparison between criterion referenced and norm referenced grading. There was little difference between the groups' test scores, but the norm-referenced group had far more complaints about the grading system. The authors concluded that "The knowledge and understanding of economics gained by students in this system was at least as great as that achieved by students in traditional classes, but at a much lower cost to the University." (P. 9.) For more detail, and for information on other studies at the University of South Florida, see G. Hartley Mellish, Diane Bostow, Nick Mystic, and Darrel E. Bostow, "A Behavioral Approach to the Teaching of Principles of Economics." Atlantic Economic Journal, November, 1974. An unpublished 53-page paper with the same title is available from the authors at the University of South Florida in Tampa.

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Negus, P.E., "Individualized Learning and Economics," Economics: The Journal of the Economics Association, Volume XII, Part 2, Summer, 1976, pp. 91-96.

Two economics instructors at the Arnold and Carlton College of Further Education in Nottingham, England, have introduced a

*These are often referred to as "the Sterling Institute Materials." (For other studies of these materials, see Craig and O'Neill, above, and Soper and Thorton, below.)

system of self-paced instruction in the introductory principles course. The syllabus is broken down into "blocks" or units of work. Each of the units contains basic information, references to textbooks, cassette tapes, newspaper articles, exercises, multiple choice questions, essays, and topics to prepare for in tutorial sessions. Students work through the units individually or in small groups, and then present their work for marking and discussion.

Students work at their own pace and in whatever sequence they prefer, except where mastery of one unit is essential before studying a later one. Some form of assessment is included in most of the units, usually consisting of multiple choice questions plus several problems requiring practical application. There is no formal classroom instruction; the instructors serve as tutors for individuals or small groups. After completing a block the student meets with the tutor to discuss the content and the questions.

Evaluation was rather informal during the first year, but it was concluded on the basis of student reaction and test performance that about half favored the new approach and that "able students may perform better under individualized learning conditions than more mediocre students." (P. 96.) The lack of whole group discussion guided by the instructor was seen as a weakness, but the tutorials enabled the instructors to identify the weak points in each student's understanding and provide a remedy. The students read more, wrote more essays, and completed more exercises than those in the conventional classes. The instructors felt that their relations with students improved, but that they were compelled to do more work because of the students' greater output.

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Newton, Jan M., and Fred J. Abraham, An Exploratory Study of the Effectiveness of Alternative Instructional Procedures in the Teaching of the Principles of Economics. Unpublished paper. Eugene: University of Oregon, 1973. 25pp. + appendices.

Newton and Abraham compared their "interview method" with students taught in conventional large lecture sections and with those taught in small discussion groups of 15 to 30 persons. The large lecture section was taught by a veteran professor with an excellent reputation for teaching. Two mid-term examinations, a final examination and an "all section final" were administered in the large lecture section. The small discussion groups were taught

by graduate students who were permitted to select their own teaching techniques.

Students in the interview section did not take comprehensive tests during the term, but took the "joint final" at the end. After studying from 12 to 20 pages of the assigned textbooks, the students would be interviewed by undergraduate teaching assistants (students who had passed the course at the "A" level). The interviews would last about 15 minutes, and the student's discussion of the text material would be judged "satisfactory" or "unsatisfactory" by the teaching assistant. This would then be recorded on the individual's progress sheet. If an "unsatisfactory" judgment was made, the student would be permitted to repeat the interviews until "satisfactory" was achieved. Upon achieving a "satisfactory" rating the student would become an interviewer for other students. After two interviews as student and two as listener, the individual would take a written test on the material covered. This was a 20-minute open-book examination. All questions had to be "functionally correct" if a rating of "satisfactory" was to be achieved. Otherwise, the student had to re-study the material until a "satisfactory" rating was obtained. Alternative sets of questions were available for the re-testing. Individual tutoring was provided for students who had problems. The student's course grade depended upon the number of units mastered. Thus, the student could, in effect, decide what grade to achieve and work accordingly.

The items in the "joint final" were selected from the TUCE. This examination counted toward the course grade in the large lecture sections and the small group sections, but not in the interview sections. The students in the interview sections were required to take the test but were told it would not count. This proved to be a mistake, as students often left within ten minutes. This was later modified so that the final examination score did have some effect. It could not be used to raise a student's score, but poor performance on the test might lower the individual's grade.

Revisions were made in the interview format each time it was employed, and the researchers did not control for possible differences in age, sex, academic ability, and the like. Students were not randomly assigned to the three instructional groups, but the authors considered the students to be "reasonably matched." (P. 4.) The fact that in the interview section there was a high proportion of A's and B's led "to some disenchantment among students and faculty. (P. 13.) The Economics Department became "concerned about the'problem' of equity caused by the huge and imposing disparity in grade distribution in two sections of the same course." (P. 13, footnote.) To rectify this, the authors required students working toward an A grade to submit additional papers.

Newton and Abraham claim some benefits for their interview system. They write: "...our extensive contact with students in the interview section convinces us that they learn a good deal more than in other conventional teaching approaches...." (P. 13, footnote.) They also assert: "In a course that is not individualized, the confusion caused by a poor text may go unremedied. We think this explains, in part, the relatively poor showing made by the lecture section...." (P. 12.)

Finally, student ratings of the interview section were higher than those of the conventional sections. For example, 37 percent of one group were "very delighted" as compared with only 15 percent in the lecture sections. The students also worked harder but thought the course was easier in the interview sections.

(Also see Fred J. Abraham and Jan Newton, The Interview Technique as a Personalized System of Instruction for Economics: The Oregon Experience. Unpublished paper. Eugene: University of Oregon, 1973.)

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O'Connor, William C., A Pilot Study on the Use of Programmed Instruction in the Teaching of Intermediate Microeconomics. Ph.D. thesis. Boulder: University of Colorado, 1974. Pp. 200.

Concerned about the paucity of research in the intermediate courses, O'Connor devoted his doctoral study to an experiment with programmed instruction at the University of Missouri, Columbia, involving about 100 students in the intermediate micro course. Three of the nine sections of the course were chosen at random, yielding usable data on 97 students.

There was one control group, receiving conventional instruction, and two treatment (experimental) groups. Treatment group number 1 used programmed materials exclusively, while number 2 used programmed material in conjunction with the traditional lecture method. The treatments were randomly assigned, and students were not permitted to choose between treatments.

O'Connor chose a non-equivalent control group design. (See Donald Campbell and Julian Stanley, Experimental and Quasi-Experimental Designs for Research. Chicago: Rand McNally, 1970.) In this design, groups are pre- and post-tested but "they do not

have pre-experimental sampling equivalence." (P. 81.) Part 2, Forms A and B of the TUCE were used, plus a common final exam (not developed by the researcher or any of the course instructors), and a test of attitudes toward the course. The pre-test mean scores were almost identical, and the students were homogeneous in terms of other characteristics. The students were told that their TUCE score would count toward their grades.

Sixteen independent and four dependent variables were included in the multiple regression analysis. Stepwise regression was used to choose independent variables which provide the best prediction with least number of independent variables. The four dependent variables were: TUCE post-test score (Part 2, Form B), simple gain score (post-test minus pre-test), gap closing score, and final exam score (40-item objective test). The independent variables included class standing; major field; whether the course was elective or required; mathematics background of student; high school economics background; pre-test score on TUCE (dummy -- upper or lower half on Form A); SCAT score (dummy -- upper or lower half); GPA; student's expected grade; student interest in economics; attitude regarding importance of economics; opinion on whether economics should be required; use of programmed instruction only; use of lecture with programmed instruction; conventional lecture method; and a dummy for split-halves of each treatment.

O'Connor found that the GPA, pre-course interest in economics, and score on the TUCE pre-test were significant in predicting student achievement in the intermediate micro course. The pre-TUCE score was by far the most significant, however. The treatments were not significant in explaining the dependent variables. That is, all three methods were about equally effective in teaching the course, at least when considering the results in the aggregate. But O'Connor also divided the students into upper and lower halves according to their pre-TUCE scores. This revealed that programmed instruction was most effective for the poor (lower half) students, while the better (upper half) students did better with programmed learning plus lectures. O'Connor warns that his research is confined to only one college and that his study was considered to be a pilot. His final chapter is devoted to suggestions for further research with a proposed design for such research.

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Paden, Donald W., and M. Eugene Moyer, "The Relative Effectiveness of Three Methods of Teaching Principles of Economics," The Journal of Economic Education. Fall, 1969, Volume 1, Number 1. Pp. 33-45.

In this study at the University of Illinois one group of students was taught by televised lectures, a second group had a live instructor, and the third used a programmed textbook. The first two groups used a conventional principles textbook; the third used only the programmed material plus the outline-study guide which was given to all three groups. Lectures were given twice a week in the TV and live lecture groups, supplemented by a quiz-discussion session under the direction of a graduate assistant. The programmed text group also had quiz sessions and were given the opportunity to meet with a staff member who would answer any questions they might have. (Few took advantage of this.) To minimize the differential effects of the six teaching assistants, each taught a TV section and a live or programmed section.

An examination developed by the authors was used as a pre-test. Later, the students took Form B of the Test of Economic Understanding (TEU), published by Science Research Associates. They also took a 189-item multiple-choice test covering the concepts included in the course. A questionnaire on attitudes toward the course and method of instruction was also administered.

The programmed group achieved higher scores on the tests, both before and after adjustments were made for such variables as pre-test performance, major field, hours spent in studying economics, and scores on the American College Test (ACT). The differences were not statistically significant, however.

Paden and Moyer advise other researchers to consider class, pre-test score, major field, credit hours completed, grade point average, number of absences, and ability when analyzing group performance in economics. They also measured the impact of the six teacher assistants but found no significant effect, possibly because each student had a complete outline and detailed lesson objectives. (These teaching assistants did influence student attitudes toward the course, however.)

The authors make an important point regarding the use of the attitude questionnaire. As they put it, "one cannot know whether attitudes influenced test scores independent of the kind of instruction received or whether the form of instruction received influence attitudes." (P. 38.) Thus, they presented attitude indices both as independent variables helping to explain test scores and as dependent variables whose variation is perhaps explained by the kind of instruction received. Their conclusions about attitudes are considered tentative. Students in the programmed group had a lower

average index of attitude toward the course than those in the other groups, but the difference was not statistically significant. Live instruction was more popular than the other two methods.

The authors conclude that the three methods were about equally effective, but that TV and programmed learning "would seem to be much more efficient than live instruction with its large expenditure of teacher time." (P. 45.) (Also see Paden and Moyer, "Some Evidence on the Appropriate Length of the Principles of Economics Course," The Journal of Economic Education. Spring, 1971, Volume 2, Number 2. Pp. 131-137.)

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Petr, Jerry L., Experimental Use of "P.S.I." or the "Keller Plan" in Principles of Economics. Unpublished paper. Lincoln: University of Nebraska, 1974. 15pp.

Petr describes an experiment in which two sections of an introductory macroeconomics course were exposed to different instructional methods. Petr taught both sections, assigned the same textbook, and gave the students no prior knowledge that they were involved in an experiment. Each section contained about the same number of students (between 80 and 90). There was no statistically significant difference between their mean grade point averages. The control section was taught by conventional methods; the experimental group was exposed to P.S.I. The experimental students were tested and compared with the controls in terms of relative gain in economic knowledge and in terms of attitudes toward the subject matter and the instructional technique. Forms A and B of the TUCE (Part 1) were used on a pre-test and post-test basis. Attitudes were measured by an attitude questionnaire and a course evaluation form.

The course content was divided into 22 teaching units. A study guide was prepared for each unit, giving the objectives and assignments in the text, workbook, and book of readings that related to those objectives. Two or more "mastery tests" were prepared for each unit. Complete mastery of each unit was expected, and students could appear at various times to take the examinations in a "testing room." If a student failed to master the material, he or she was expected to study again and take a different form of the test later. Upon demonstrating "requisite capability," the student was given the study guide for the next unit. Mid-terms and finals were also given.

Criteria for course grades were established. To get an "A", for example, the student had to master all 22 units and achieve a score of 80 percent on the final. In the control section, where the lecture-discussion technique was used, the students took two "hour exams" and a final, and wrote a paper. Students in both groups took the appropriate parts of the TUCE, pre and post, but their performance on this test did not influence final grades.

The performance of the P.S.I. students was significantly better than that of the control group. Their pre-test means were identical (12.75) but the P.S.I. section ended with a mean of 21.20, while the control group achieved a post-test mean of only 17.57. Furthermore, the P.S.I. students' gain was greater than that of the national norm group (8.45 as compared with 5.62). Course grades also differed. In the P.S.I. section 25 students attained "A" level performance, while only 15 of the conventionally taught students reached this level.

In terms of attitudes, the P.S.I. students felt they had learned more, and in other ways gave the course higher evaluations. These higher ratings were statistically significant for "General self-development," "Developing communication skill," "Pursuing own interests," "Understanding intellectual-cultural values," "Instructor's interest in students," "Fairness of grading," and "Quality of text and learning material." Petr concluded that P.S.I. "is a teaching technique with merit" (p. 11) and that it "can be an effective and popular technique for generating student mastery of the content of Principles of Economics." (P. 14)

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Roop, Joseph M., "Contingency Management in the Teaching of Economics: Some Results from an Intermediate Microeconomics Course," Intermountain Economic Review, Spring, 1973. Pp. 53-71.

Roop, Joseph M., The Application of Contingency Management to the Teaching of Economics. Unpublished paper. Pullman: Washington State University, n.d. Pp. 15.

B. F. Skinner defined teaching as the arrangement of contingencies of reinforcement under which students learn. Roop used the contingency management approach in an intermediate micro course at Washington State University. (Note that few economic education studies have involved the intermediate level.) This approach is based upon the psychology of operant conditioning, which establishes

a correlation between some aspect of behavior and reinforcement or punishment. Reinforcement is contingent upon certain specific responses, hence the term "contingency management."

First, the instructor identifies the responses he or she wants to reinforce; second, a reinforcing stimulus is identified (such as a course grade); and finally, specifies the contingencies which come between response and reinforcement. A common practice is to specify a number of points to be awarded upon successful completion of a unit of work, base the grades on numbers of points, require that a high level of mastery be achieved, and award the final course grade on the basis of the total amount of work. The total amount of work, then, is the reinforcer -- the factor determining the final grade. Many variant forms are possible for a contingency managed course. Student progress can be student-paced or can be controlled by the instructor.

When used in other disciplines, Roop maintains that this approach resulted in superior student performance and was preferred by the students. He attributes this to the fact that requirements for each unit are specified, grade requirements are clearly defined, and the student receives immediate reinforcement after each unit. Roop's intermediate micro course was designed to give students experience in reading textual material, summarizing information, evaluating arguments, developing bibliographies, presenting oral arguments, engaging in research, and writing reports. Students could do only a few of these things and still achieve a passing grade. For example, studying the text and summarizing several sets of readings might result in a "C." The ten weeks devoted to these activities were instructor-paced. For a "B" a student would have to read professional literature, develop bibliographies, and give an oral report. Those wanting an "A" had to formulate hypotheses on controversial issues, examine and weigh evidence, and write a report on their findings. These activities were entirely student-paced and were engaged in during the last six weeks of the course.

The first part of the course was divided into ten blocks. A quiz was given at the end of each block, and any student missing more than 20 percent of the questions would have to retake the test. Although this portion of the course was instructor-paced, students could make choices about the combinations of readings they would use. If a student desired nothing more than a "C" he or she could stop at the end of this part of the course. To evaluate the approach, Roop gave an examination at the beginning of the first block and at the end of the tenth, comparing the results with those achieved by students covering the same material in the traditional manner. (The exam was written by another instructor.) The experimental group scored significantly higher (at the .01 level). Roop cautiously concludes that contingency management is superior to

conventional methods, but notes that there were many uncontrolled factors in the experiment. Roop also considers Kelley's TIPS (described above) to be an example of the application of operant principles to economic education.

This study suggests that some of the individualized or self-paced techniques used in the introductory course can also work at the intermediate level. Obviously, however, much more research is needed.

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Siegfried, John J., and Stephen H. Strand, "An Evaluation of the Vanderbilt-JCEE Experimental PSI Course in Elementary Economics," The Journal of Economic Education. Fall, 1976, Volume 8, Number 1. Pp. 9-26.

One of the most interesting things about this study is that the authors address themselves to some of the problems noted by other researchers. (Possibly this is because the Siegfried-Strand paper is one of the most recent on PSI.) They use a specially designed test instead of the TUCE, for example, they consider costs as well as benefits, and they measure the impact of the P.S.I. experience on the student proctors. (Note the questions raised by Spector in his second paper, described below.) Furthermore, this study is a follow-up to the work of Fels, described above.

This paper deals with the experimental P.S.I. course at Vanderbilt University in Nashville, Tennessee, as it was taught in the fall of 1974 and spring of 1975. First the researchers report the effects on student learning. Two tests were designed for this purpose -- a 25-item multiple-choice "Test of Elementary Economic Analysis" (TEEA) containing eight recognition-understanding questions and 17 application items, and an essay examination of three questions. By constructing tests tailored to the course they avoided the problem often encountered by those using standardized instruments; that is, questions on material not covered in the course. On the other hand, this prevents comparisons with a national norm group.

The TEEA was administered on a pre-test, post-test basis. (Unlike the TUCE, no alternate forms were available.) Scores were also obtained for each of the three essay questions. The TEEA plus the essays constituted the final exam. In addition to scores on the TEEA (pre and post) and scores for each of the three essay

questions, four summary indices were constructed. The first of these four indices -- called Y_6-- was the final exam score, with the TEEA and each essay weighted equally. The second, Y_7, was the sum of the essay scores, with each weighted equally. The third, Y_8, was the difference between TEEA post-test and pre-test scores (simple change score). Since Y_8 is biased against students achieving high pre-test scores, the fourth (Y_9) was a gap-closing score. (The gap-closing score is obtained by dividing the simple change score by the student's gap, which is the difference between the pre-test score and a perfect score.) Students in both the P.S.I. and conventional (control) sections were tested, and data on student age, sex, grade point average, SAT scores, experience in quantitative methods course, parents' occupation, and number of concurrent credit hours were obtained. (Parental occupation was a binary variable -- business-related or non-business-related occupation.) Students were permitted to choose their sections, P.S.I. or conventional. (In some other studies students were not given this choice.) Students with low GPA's tended to avoid the P.S.I. course, which was reputed to have high standards. The results? Only in the third essay question (requiring an analysis of two alternative fiscal policies in early 1975) did the P.S.I. students reveal statistically significant superiority. This may reflect the emphasis upon policy analysis in the P.S.I. course. There was no significant difference between the experimental and control groups on Y_7 (overall essay performance), Y_8 or Y_9. Multiple linear regression analysis showed that only SAT scores and GPA were statistically significant in affecting student learning of economics. P.S.I. "apparently neither helps nor hinders that degree of learning," Siegfried and Strand conclude. (P.14.) A possible explanation, however, is that the unit tests were too difficult and thus reduced student self-confidence and motivation, according to the authors.

The P.S.I. course, which at Vanderbilt also included the case study approach, was expected to have the effect of improving performance in later courses as well. P.S.I. students were compared with control students taking the second semester of the principles course. That is, some of the students in the second part of the course had been P.S.I. students during the first semester, while others had had conventional instruction. Controlling for the initial level of economic understanding, the researchers found no significant difference between the performance of the two groups. "If there were any difference in subsequent learning between P.S.I. and conventionally trained students that derives from different study habits or analytical skills developed in the first semester elementary economics course, it did not persist even through the very next course." (P.17)

Student perceptions of the course were high. An evaluation questionnaire revealed that the P.S.I. students gave their course

significantly higher ratings for organization of the course, usefulness of assignments and reading, increasing their ability to think, evaluate, and criticize, and contributing to their overall learning experience. The P.S.I. professor received a more favorable rating than the control instructors, and the P.S.I. exams were seen as being more instructive and fairer.

The P.S.I. students devoted more time to the course, but this was not statistically significant. The student proctors, however, spent much more time on the course than they would have spent in taking an upper level course themselves -- twice as much in some cases. (The proctors received three academic credits for their work.) The proctors were juniors and seniors with good GPA's, and all 21 of them thought they learned more from proctoring than they would have learned in an upper-level course. The 100-item economics CLEP test was administered to ten of the proctors and a control group of 20 matched students taking higher level courses. The results substantiated the proctors' feeling that they learned more economics. (The CLEP was administered on a pre- and post-test basis, and the gap-closing model was used.) If the cost to proctors was high in terms of time spent on the P.S.I. course, the benefits were even higher. Proctoring was related to a 20.8 percent increase on the CLEP, while taking an advanced course resulted in an increase of only 7.8 percent.

Start-up costs are high for a P.S.I. course, but even beyond start-up costs the instructor at Vanderbilt felt that he was devoting more time to P.S.I. than he would normally spend on a three-credit course.

Finally, the effect on interest in majoring in economics was measured. Fourteen percent of the conventionally taught students elected to major in economics as compared with 12 percent of the P.S.I. students, but the difference was not statistically significant.

Although Siegfried and Strand consider their results "discouraging," they justify the continuation of the course because of favorable student evaluations of it and the benefits enjoyed by the upperclass proctors.

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Soper, John C., "Programmed Instruction in Large-Lecture Courses," The Journal of Economic Education. Spring, 1973, Volume 4, Number 2. Pp. 125-129.

Soper points out that the use of programmed instruction, when

used to complement conventional techniques in the principles course, frees the instructor from the task of drilling students on material that is largely definitional and mechanical and allows him or her to concentrate on more complex learning situations. It allows "greater adaptability to individual differences in learning speed." (P. 125.)

In this study, Bingham's Economic Concepts: A Programmed Approach (McGraw-Hill) was used in conjunction with lectures in a one-semester course enrolling about 1000 students at the University of Missouri (Columbia). Nine unit quizzes made up of five multiple-choice items were developed, with five forms for each quiz. Students failing a quiz would continue to take different forms until one was passed with 100 percent mastery. Each "pass" gave the student a "bonus point" which was added to his or her exam and lab average in determining final grade.

When asked to rate the materials, students on the average ranked the programmed quiz package first. The "hybrid TUCE"* was used for pre- and post-testing. With the post-TUCE score being used as the dependent variable, the absolute improvement model indicated a statistically significant relationship (.01 level) between points earned and post-TUCE score. Indeed, about 12 percent of the post-TUCE score was explained by the bonus point variable. There was a negative coefficient for the number of attempts made at passing the quizzes, probably because students who had to try several times were not as bright as the others.

The gap-closing model was also used; this to compensate for the ceiling effect of the 33-item test. Here, the dependent variable is actual improvement (post-test score minus pre-test score) divided by potential improvement (33 minus pre-test score). This indicates (in percentage terms) the extent to which the student closed the gap between the pre-test score and a perfect score. Here again the number of quizzes passed is highly significant -- each bonus point closing about two percent of the gap.

Finally, overall student performance was regressed on the explanatory variables, revealing that the programmed instruction quiz package did have a positive impact on the varied measures of student performance.

*The "hybrid TUCE" is a 33-item version of the original 132-item Test of Understanding in College Economics (TUCE). The original TUCE appears in four parts, each of which has 33 items. The "hybrid" was designed for research and evaluation purposes where one wants to cover the same basic concepts but needs a shorter and more manageable test instrument. For further information see Phillip Saunders and Arthur L. Welsh, "The Hybrid TUCE: Origin, Data, and Limitations," The Journal of Economic Education, Fall 1975, pp. 13-19.

Note: In a paper entitled "Programmed Instruction in Large-Lecture Courses: A Technical Comment," William E. Becker, Jr., of the University of Minnesota challenged some of Soper's statistical techniques. Soper prepared two papers in response to this -- "Programmed Instruction in Large-Lecture Courses: A Correction, Reply, and Reformulation," and "Second Generation Research in Economic Education: Problems of Specification and Interdependence." Soper acknowledged an error in the original dataset (wherein a student's score was recorded as 66 instead of 16), agreed with one of Becker's criticisms (regarding inconsistent application of Soper's multi-collinearity argument), and found "nearly all" of Becker's comments to be appropriate. These are technical research issues going beyond the purpose of this booklet, however, and transcending the confines of the study in question. As Soper put it in his second paper, Becker's comments are "not destructive of the conclusions in the original study." (Page 16 of "Second Generation Research....")*

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Soper, John C., and Richard M. Thornton, "Self-Paced Economics Instruction: A Large-Scale Disaggregated Evaluation," The Journal of Economic Education. Spring, 1976, Volume 7, Number 2. Pp. 81-91.

The so-called "Sterling Institute materials" were used in the studies summarized above by Craig and O'Neill and by Mellish and Bostow. This seven-volume set of economics material provides instruction through a series of modular learning units. Instructors adopting the material receive sets of multiple-choice examinations, and a guide on how to use the materials and the tests in the "self-paced mode." Soper and Thornton confirm the findings of the Mellish-Bostow and Craig-O'Neill studies in terms of the effect on student attitudes, but not in terms of the impact on cognitive learning. Further, they assert that there were "some methodological flaws" in those studies. (P. 82.) Both previous studies found no statistically significant differences in cognitive gains between control and experimental students. Soper and Thornton are bothered by their failure to use multiple regression analysis, however, asserting that reliance upon tests of significance between groups (using "t" tests and/or univariate F ratios) "may obscure the effects of individual differences in such characteristics as age, sex, or intelligence on post-TUCE performance." (P. 82.) Instead, they prefer procedures that will match individual student test scores with individual student characteristics.

*For details of the disagreement between Becker and Soper see "A Debate on Research Techniques in Economic Education," The Journal of Economic Education, Fall, 1976, Volume 8, Number 1.

At Northern Illinois University the authors conducted a large-scale evaluation of the Sterling Institute self-paced macroeconomics course. There were four experimental (self-paced) sections and 15 control sections taught in the conventional manner. Graduate students taught these sections, under the supervision of the authors. The experimental sections were completely self-paced. Part 1, Form A, of the TUCE was used for pre-testing all students. There was a "preliminary screening" of the variables to enable them to determine which ones should be included in the final estimating equation. Post-TUCE scores were regressed on all exogenous variables in the data set. Soper and Thornton found "substantial multicollinearity among the explanatory variables...." (P. 83.) For instance, five ACT scores (English, math, natural science, social science, and composite) were highly intercorrelated. The same was true of college class and age. Only the ACT composite score was included in the final estimating equation, therefore, and college class was dropped and age retained because the latter was seen as a proxy for "maturity," which was assumed to be an "underlying variable" for which class and age are proxies.

The pre-TUCE score was significantly correlated with Sex, ACT, and Age. (Farrar-Glauber procedures were used here. See Donald E. Farrar and Robert R. Glauber, "Multicollinearity in Regression Analysis: The Problem Revisited," Review of Economics and Statistics, February, 1967, pp. 92-107.) However, the pre-TUCE score does contain information not correlated with those variables, and to omit such information would lead to the problem of misspecification. To overcome misspecification problems, a proxy variable was constructed. (See the complete article for details, p. 85.) This eliminated the bias associated with the coefficients of Sex, ACT, Age and pre-TUCE.

Aside from their model and experimental design (which other researchers are urged to examine), one of the most important aspects of the Soper-Thornton study is the disaggregated analysis. The TUCE questions are categorized as recognition-understanding (RU), simple-application (SA), or complex-application (CA). The researchers divided the post-TUCE into three separate scores according to these categories. The self-paced students scored .665 point lower on the recognition-understanding items, and .38 point lower on the complex-application, but these were not statistically significant. On the simple-application questions, however, the conventionally taught students scored 1.23 points higher than the self-paced students, and this was significant.

Soper and Thornton conclude that the Sterling Institute materials cannot be seen as superior. Indeed, students in the experimental group scored 2.27 points lower on the post-TUCE, other things being equal, than did the control group students. They also found that instructors can "significantly affect postscores." (P. 88.) Their study does not rule out the use of self-paced material, however.

In their words --

> "These results suggest that self-paced materials can be satisfactorily applied to the teaching of recognition-understanding type material with no, or very little, loss of competency. In a combined programmed-instruction, lecture-discussion type course this would give the instructor more freedom to concentrate on application-type material, thus upgrading the competencies acquired by economics students.... With more lecture-discussion time made available by leaving recognition-understanding type material to programmed-learning techniques, a conscious upgrading of the lecture-discussion presentation to higher level application-type problems should result in improved student performance." (P. 88.)

They conclude that "...a completely self-paced teaching format for macroeconomics is inferior to a well-directed, concept-oriented, graduate-student instructed, lecture-discussion taught course."

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Spector, Lee C., Personalized System of Instruction and Its Use in Principles of Macroeconomics at the State University College at Buffalo. Unpublished paper. Buffalo: State University College, 1974. 10pp. + appendices.*

Spector reports on an experimental use of the Keller P.S.I. method in an introductory macroeconomics course at the State University of New York in Buffalo. The experimental section was made up of about 65 students. These individuals received a syllabus which divided the textbook into eight units, a study guide for each unit, a set of learning objectives, a glossary, hints on how best to learn the material, a discussion of important topics, a bibliography, and a series of "thought questions." Ten students from intermediate courses were selected to serve as proctors for the P.S.I. group.

The students had to master a unit before proceeding to the next one. Upon feeling that the material had been learned, the student would arrange for a 15-minute discussion with a proctor. When the proctor was convinced that the student understood the material, a ten-item multiple-choice examination was administered. If the student answered nine questions correctly he or she would go on to the next unit; otherwise, an alernate form of the test would be taken until the score of nine or ten was achieved. The course grade

*Also see Spector's article "The effectiveness of Personalized System of Instruction in Economics" in the Journal of Personalized Instruction, Vol. 1, No. 2, September 1976, pp. 118-122.

was based on the number of units mastered -- eight units for an A, seven for a B, five for a C, and three for a D. The proctors monitored student progress and served as tutors.

The TUCE and student evaluations of the course were used to evaluate the P.S.I. method. The experimental group's pre-test mean on Form A of the TUCE was about the same as that of the control group -- 12.77 and 12.04 respectively. (The mean for the national norm group was 13.31.) On the post-test (Form B) the P.S.I. group achieved a mean of 21.49, as compared with 18.53 for those taught by conventional methods at Buffalo, and with 18.93 for the national norm group. The difference was significant at the 99 percent level. The student evaluation questionnaire revealed that the P.S.I. group also enjoyed the experience, thought the method was effective, and would recommend it to other students. The advantages of P.S.I., according to Spector, are constant feedback for students and instructor, ability to work at one's own speed, possible reductions in student-teacher ratios (because of the use of proctors), more "give and take" provided by oral examinations, mastery of the material, and practice in learning to work by themselves. Disadvantages are that some are unable to assume the responsibility for self-study, the lack of intraclass discussion of current events, and the waste of time that sometimes occurs. (For a follow-up of Spector's work, see the report immediately below.)

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Spector, Lee C., The Long Run Effects of Personalized System of Instruction in Economics. Paper presented at the conference of the Eastern Economic Association, Bloomsburg, Pa., April, 1976. Buffalo: State University College, 1976. 13pp.

This paper adds another dimension -- the residual impact (lasting effect) of P.S.I. -- to his earlier studies of the effect of the Keller method in undergraduate economics courses. (See the Spector study summarized immediately above.) Spector found that P.S.I. students did significantly better on the TUCE than students taught by conventional methods. He considers his earlier findings important, but "misleading" because they pertain "only to the short-run effects of the experiment." (P. 1.) In this paper, then, he deals with some of the longer-run effects. The questions are: (1) Were P.S.I. students more likely to go on to take more economics? (2) Did P.S.I. students outperform control students in intermediate macroeconomics? (3) Were the experimental students more likely to become economics majors?

The answer to the first question is "no." Only 47 percent of the P.S.I. students took more economics, as compared with 55 percent of the controls. The difference was not statistically significant at the 95 percent level. The answer to the second question is "yes." The P.S.I. students achieved higher mean grades in the intermediate courses, and the difference was significant at the 99 percent level. The answer to question (3) is "no" -- a smaller percentage of P.S.I. students became economics majors, but the difference was not significant at the 95 percent level.

In this experiment, Spector considered several variables that might have a bearing on student performance. Grade point average was used as a proxy for intelligence. Whether or not students were economics majors was the proxy for motivation. Scores on the TUCE and grades in the introductory macro course were used as measures of knowledge acquired in that course. These variables were regressed against the course grades in the intermediate macro course for all P.S.I. and control students. A dummy variable represented the method of instruction (P.S.I. or conventional); and another dummy variable distinguished those who had taken Money and Banking from those who had not. Only grade point average, being an economics major, and P.S.I. proved to be significant (at the 95 percent level). GPA was most significant. The regression did show, however, that taking the introductory course by P.S.I. would improve a student's intermediate grade by almost one-half a grade point. Thus, Spector concluded that "students receive a better foundation for Intermediate Macroeconomics" if they study the introductory material through the P.S.I. method. (P. 7.)

Spector notes that there are still some unanswered questions. What are the long-run effects on the proctors? How does teaching a P.S.I. course affect the instructor? Do P.S.I. students retain their knowledge longer than students taught by traditional methods? Is the student's work in other courses affected?

In a discussion of this paper, Alan J. Donziger of Villanova University praised Spector's work but raised some questions as well. He noted that the differences between the P.S.I. students and the control group in terms of becoming economics majors and in taking more economics courses would be statistically significant if one accepted the 85 percent level. He did not conclude from this that P.S.I. is "scaring away economics majors" or detering students from taking more economics, but he thought that a consistent pattern of similar results would bear watching. Spector's assertion that P.S.I. provides better preparation for work at the intermediate macro level was seen by Donziger as "reasonable." He expressed concern, however, about the problem of multicolinearity. (See the Soper-Thornton study cited above for further consideration of this problem.) A basic question raised by Donziger is: "If

students who had P.S.I. principles courses do perform better in Intermediate Macroeconomics, does this mean that P.S.I. helps students learn more (somehow defined) in future courses, or does it make them more proficient at taking examinations?" (Quoted from Donziger's paper "Discussion on The Long Run Effects of Personalized System of Instruction in Economics." Villanova, Pa.: Villanova University, 1976. 6pp.)

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Tietenberg, T.H., A Comparative Analysis of the Personalized System of Instruction with the Lecture Method in Terms of Five Alternative Output Measures. Unpublished paper. Williamstown, Mass.: Williams College, n.d. Pp. 22.

Tietenberg, T.H., "Teaching Microeconomics Using the Personalized System of Instruction: An Evaluation," in James Johnston, Ed., Behavior Research and Technology in Higher Education (Springfield: Charles C. Thomas, 1974).

Tietenberg is one of the few to report studies at the intermediate level -- in this case an experiment with P.S.I. in an intermediate micro course at Williams College. The focus was on five different outputs: (1) performance on the final exam; (2) performance in courses taken concurrently; (3) performance in the macro theory course; (4) performance in subsequent micro course electives; and (5) decisions on majoring in economics and political economy. The lecture format was compared with P.S.I.

The P.S.I. students could proceed at their own pace (within limits) and had greater flexibility in allocating the time spent on the course. The professor was available for individual consultation, which made it possible to "personalize" instruction by relating economics to problems of interest to the student. The course was divided into units, each unit containing an introduction relating the material to previous units and to the course in general, a set of objectives, a set of procedures, and a set of sample problems or questions. Upon achieving a perfect or near-perfect score on a unit test, the student would go on to the next unit. Failing a unit test would have no effect on the student's grade, but it would slow him or her down. At the beginning of the semester the student would know what had to be done to earn an A, a B, a C, and so on.

The 92 students participating were divided into three sections, two of which were taught in the conventional manner. A

standard textbook was used, but the P.S.I. group also received handouts to supplement the text. These were designed to provide the kind of elaboration ordinarily provided by lectures. Unfortunately, it was not possible to have one professor teach both experimental and control sections, thus differences in teaching ability had to be taken into account. Furthermore, students were permitted to select their preferred section.

A common final exam was prepared, made up of objective and essay questions. This was constructed by the three faculty members teaching the course. Each faculty member graded one part of the test without knowing the name of the student whose paper was being evaluated. The final exam score was the dependent variable in a multiple regression analysis. This was regressed against several control variables. P.S.I. was a binary variable taking the value 1.0 for a student in the experimental section and 0.0 for the control student. There was also an interaction variable, PSIGPA, which took the value of the student's economics GPA upon entry into the course if the student was in the P.S.I. section (zero otherwise). A positive sign on PSIGPA would indicate that the benefits of P.S.I. were greater for students with strong records of past performance, after controlling for the other variables in the equation. SAT math and SAT verbal scores were taken into account, as were age, sex, taking the final exam early, and the teaching experience (in years) of the instructor.

Tietenberg concluded that there was "a breakeven economics grade point average." By this he meant that a breakeven economics GPA exists when all students above that average are estimated to gain more from P.S.I., and all students below that average are estimated to gain more from the traditional method. The breakeven economics GPA was estimated to be a C minus, in this experiment. The P.S.I. format, it was estimated, led to higher final exam scores than did the lecture method for comparable students, but the difference was not statistically significant.

In courses taken concurrently (including those other than economics), grade point average for those courses was the dependent variable. The breakeven economics GPA in this instance was slightly below a B. That is, of all the students who entered the course with a B average in economics (or better), those who were in the P.S.I. group were estimated to do better in their other courses taken during the same semester than those with comparable characteristics who attended lecture sections. The results were not statistically significant, however.

Students involved in the experiment who took macro theory in the following semester were further analyzed, with the grade in the macro course regressed against the same variables used in the earlier model. The breakeven point was between B and B plus for this group. P.S.I. students entering the earlier micro course

with a B plus economics GPA were estimated to have performed better in macro theory than similar students who studied micro under the lecture method. Again, the differences were not statistically significant.

Performance in subsequent micro courses was measured by GPA in those courses. Here, the breakeven point was between B minus and C plus, and although those coming from the P.S.I. experience did better than their peers if they were above the breakeven point, and those below it did better if they had been in the lecture sections, the differences were not significant.

Finally, a two-group discriminant analysis was used to see if P.S.I. affected decisions to major in economics. This analysis uses a vector of independent variables to classify the sample into two groups where one knows the appropriate classification beforehand -- in this case the groups being those who chose to major in economics or political economy and those choosing some other field. In his unpublished paper (p. 18) Tietenberg explains:

> "The ex post classification takes place by estimating a linear discriminant function and using this function to generate an estimated discriminant index. When the value of the index is higher than some critical value, the observation is assigned to the first group. All other observations are assigned to the second group. By examining the discriminant function coefficients and performing the appropriate hypothesis tests on them it is possible to study the effect of the teaching format on the decision to major in these fields and the statistical significance of these results." (For the appropriate test, see George W. Ladd, "Linear Probability Functions and Discriminant Functions," Econometrica, October 1966, pp. 873-885.)

In this instance the breakeven grade point average was C. That is, students entering the experimental course with a C average (or better) were slightly more inclined to major in economics or political economy if they were in the P.S.I. section. Those with a C minus or below were slightly more apt to major in that field if they were taught by the lecture method. The differences were far too small to be statistically significant, however.

Tietenberg concluded that "the P.S.I. format was neither inherently superior nor inherently inferior to the lecture format in any of these dimensions." (P. 19, unpublished paper.) However, he was struck by the "remarkable consistency in the distribution of these differences among students with differing...competence in economics prior to their taking the experimental course." (Pp.19-20, unpublished paper.) The students did seem to gain more f om P.S.I. in all five of the educational outputs if they had good records in

their previous economics courses. Tietenberg thought that P.S.I., therefore, might be "biased toward the more capable student," but suggested further research on this point.

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Tolles, N. Arnold, and Peter J. Ginman, "Using an Audiovisual-Tutorial Process in Macroeconomics," The Journal of Economic Education. Fall, 1974, Volume 6, Number 1. Pp. 57-58.

The audio-visual tutorial (AVT) process developed at the State University of New York College in Geneseo permits the student to bear part of the responsibility for teaching, and can be used for individual study and self-paced instruction. Usually the student takes a pre-test, reviews the unit material in a workbook, listens to an audio-tape, and views 35-mm slides which accompany the tape. Difficult sections may be repeated, of course, and the student takes both a "self-instructional test" and a test for credit. (See David A. Martin, Introductory Economic Theory. New York: McGraw-Hill, 1971.)

When the materials were used at Geneseo, it was found that the students could complete a standard basic macroeconomics course in only eight weeks. The authors report that student evaluations of AVT were "highly positive." During a spring semester the researchers relied entirely upon self-study with the AVT materials. In the fall they tried a different approach, having the students meet their instructor in discussion sessions after having used the AVT materials. There was also "class-assisted use" of the AVT material. Student improvement was greater in the fall, suggesting that the combination of AVT and conventional discussion methods may be superior to AVT alone or to the traditional approach alone. The combination method seemed to be better for weak students. The authors pointed to the need for more controlled experimentation, however. (See the Becker and Salemi study, above, for an evaluation of the Geneseo AVT material. Also see Walstad's study, below.)

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Van Metre, Dale, Principles of Learning and Introductory Economics: A Discussion and an Experiment. Unpublished paper. Ogden, Utah: Weber State College, 1974. 21pp.

Before describing his experiment with P.S.I., Van Metre makes

a number of interesting observations about teaching techniques and research. He notes that many studies do not attempt "to match the modes of instruction with the particular kinds of learning to which they may best be suited." (P. 1.) He discusses instructional objectives and cites research showing that "student achievement in an economics course is significantly improved when instructional objectives are used." (P. 3.) Van Metre asserts that "people generally learn more when they are actively participating in the learning process," (P. 6) and that a change in "the method of instruction has no logical potential for changing student performance unless it changes what the student is doing." (P. 7.) He feels that "learning takes place within the individual according to each individual's 'internal conditions of learning' such as the desire to learn, willingness to follow directions, amount of prior learning, etc." (P. 8.) Finally, he notes that the lecture method "is likely to frustrate those students who would like to learn faster and will penalize those students who...can't learn as fast as the course plan dictates." (P. 8.) (Also see his article "A Learning Theory of Economics Instructional Development," The Journal of Economic Education, Spring 1976, pp. 95-103.)

Van Metre's experiment involved the evaluation of a course patterned after the Keller method of P.S.I. Six units were prepared, each containing a list of objectives, a programmed study guide which accompanies a basic textbook, practice exercises, readings on current economic issues and audio-visual media. Examinations were prepared for each unit. Students set their own learning and testing schedules, but had to complete all six units by the end of the term. Students could re-take the tests (using different forms), which might raise or lower their grades. Note that Van Metre's use of the Keller method thus differs from that of some others wherein re-testing could raise grades but not lower them. He would multiply scores on the first re-take by 0.92 and on the second by 0.84 "to encourage the students to study more between retakes and to not use the tests only as learning devices." (P. 10.) Furthermore, each test contained at least one essay question. Tutoring was available daily, and unit workshops were held to discuss current issues and the more difficult course objectives. There were also "extra credit discussions" dealing with the assigned readings on controversial topics. Each student had to complete all six units at a specified minimum performance level, whereas in some colleges the students were not required to finish all of them.

The experimental course was taught for three quarters during one academic year at Weber State. Sections taught by experienced professors using conventional approaches were used as controls. Van Metre controlled for student abilities by including ACT scores

and cumulative grade point averages. The equation (using least squares regression techniques) also included a dummy variable for sex, and a dummy variable for teaching method. Part One of the TUCE was used, Form A for pre-testing and Form B for post. The gap-closing model was employed. This measures the extent to which the student closes the gap between the pre-test score and a perfect score. The pre-test score is deducted from the post-test score to provide the numerator. The pre-test score is deducted from 33 (a perfect score) to yield the denominator. (This is the "gap" or the student's potential improvement.) The result is an indication, in percentage terms, of how well the student closed the gap. (This gap-closing model is now widely used in economic education research, but it is still under study. For example, see Paul H. Kipps, Howard M. Wilhelm, and Daniel R. Hall, "A Note on the Use of Multiple Regression Analysis in Studies of Achievement in Economics," The Journal of Economic Education, Spring 1976, pp. 130-132.)

The regression analysis revealed that ACT score and GPA were highly significant (above 99 percent), and that the method of teaching was significant only if one accepts a level of 89.6 percent. Students in the P.S.I. course would be expected to achieve 6.7 percent more of their potential improvement than those in conventional courses.

Van Metre hesitates to draw firm conclusions from his study. He points to sources of model misspecification, such as the lack of variables to account for differences in teacher abilities and objectives. Even if textbooks and objectives are the same for all students, he notes, teachers might emphasize some objectives more than others. He thinks that "the motivations and expectations of the teacher" might influence student performance. (P. 14.) Student age, marital status, employment situation, and attitudes might also have an effect. "The maturity and motivation of students is important too, because more responsibility is placed upon students in a P.S.I. course than in a lecture course." (P. 15.) Other important points made by Van Metre are as follows:

"To say that a given teacher will have success with, say, group discussion because a study showed it successful for a different instructor doesn't make sense." ... "A teacher's ability to instruct varies across methods...." (P. 15.) "Most previous studies have implicitly assumed that a particular method is equally effective for all types of learning or that there is only one type of learning outcome in elementary economics. Future studies must distinguish among types of learning and do so under conditions for more teacher variables than did this present study." (P. 16.) "Final test performance is not the only method by which teaching efforts can or should be evaluated." ... "Our ability to measure how well the elementary economics course teaches students attitudes toward economics, intellectual problem solving, alternative

value systems, etc. is very weak. We also don't adequately measure the extent to which our courses teach students to logically handle new situations using unfamiliar approaches." (P.17.)

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Walstad, William B., An Alternative to the Conventional: The Audio-Visual-Tutorial Method for Teaching Introductory College Economics. Unpublished paper. Minneapolis: University of Minnesota Center for Economic Education, 1975. Pp. 15.

Walstad's study differs from most others in two respects. First, it is one of the few to deal with two-year colleges. Second, several schools were included in the experiment, whereas most studies involve students from only one institution. The study was designed to measure the impact of David Martin's audio-visual-tutorial (AVT) package, Introductory Economic Theory (New York: McGraw-Hill, 1971). (For other studies involving this AVT package see Becker and Salemi, and Tolles and Ginman, above.) AVT was compared with the conventional lecture-discussion approach both in terms of student learning and effects on student attitudes toward economics.

Three two-year colleges in Minnesota and three in Missouri were included in the study, and usable data were collected on 330 students. Students at each college were randomly assigned to control and experimental groups. There were no significant differences between groups in terms of age distribution, sex, class, and previous college work. Each instructor received information about the study and attended a one-day workshop to learn to use the AVT package. One instructor at each college taught both the experimental and control classes.

The AVT package includes 35 mm color slides, audio-tapes, and a worktext that includes instructional self-study aids. Basic micro and macro theory are covered. After an introductory class session in which students were shown how to use the materials and operate the equipment, the students were to use the AVT package for the next nine sessions in place of the usual class lectures. Pre-tests and post-tests were administered with each unit. If performance on the post-test was poor, the student was instructed to review the unit and retake the test. Meanwhile, students in the control classes were covering the same concepts via lecture-discussion. Instructors were available to help AVT students having problems.

Forms A and B of the TUCE were used for testing economic understanding. No significant differences were found either on the pre- or post-tests between experimental and control groups. A multiple linear regression analysis was made, with sex, age, pre-test score, post-high school work in economics, whether or not economics was required, pre-course interest in economics, college attended, and being in a control or experimental group as the regressors. The post-test score was the dependent variable. The pre-TUCE variable was a significant contributor to student learning, and significant differences were found between all the colleges in regard to student learning of economics. Walstad was unable to explain the college differences. Thus, Walstad does not support the Tolles and Ginman finding that the AVT program was more effective than conventional instruction. Giving it a more positive interpretation, however, he points out that his findings do indicate that students can learn economics on their own by using the AVT package, and that they will learn as much as conventionally taught students. There was no "important difference" between control and experimental groups in terms of student post-course ratings of economics. Walstad's conclusion is that "The AVT method may offer economic instructors and students an alternative to the conventional without concern over a drop in student achievement or attitudes towards economics." (P. 15.) (For additional details see Walstad's The Effectiveness of an Audio-Tutorial Approach for Teaching Introductory Economics in Selected Two-Year Colleges. Unpublished M.A. paper, University of Minnesota, 1975.)

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Wetzel, James N., Measuring Student Effort in the Economic Principles Course. Richmond, Virginia: Virginia Commonwealth University, 1976. 14pp. (Unpublished paper, submitted to The Journal of Economic Education.)

Wetzel's study does not concentrate on personalized, individualized, or self-paced instruction, but his conclusion does raise an important question about the advantages of such instruction.

Illustrating his point with an indifference curve, Wetzel asserts that an improved teaching technique (represented by an outward shift of the transformation curve, where "Achievement in Economics" appears on the horizontal axis and "Leisure Time" appears on the vertical) enables the student to learn more economics, enjoy more leisure (a proxy for anything other than

studying economics), or a combination of both. He found that student's expected grade and final grade were positively correlated with student effort, significant at the .05 level, and that day students exerted more effort than evening students. (For more information on the "effort variable" see the learning theory of Richard B. McKenzie and Robert J. Staff in their book An Economic Theory of Learning. Blacksburg, Virginia: University Press, 1974.) He supports "the belief that final grades are a result of both effort and ability." (P. 9.) There are implications of his study for research on comparative teaching techniques, he feels. In his words: "The incorporation of decision making theory into the evaluation process and its implications for the student's trade-off between achievement and leisure are quite important. The real advantage of TIPS, personalized instruction or teaching by television, may not be higher achievement in the course under consideration. The real advantage may be that less real effort needs to be spent on that particular course which leaves more student leisure time available for other purposes the student has in mind." (P. 10.)

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